DEC STD 116-1 Workmanship Standards Manual - Module Assembly

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ABSTRACT: This document provides the workmanship criteria to be applied in the manufacture, rework and repair of Digital fully-assembled, printed-wiring boards.

APPLICABILITY: This manual is used as a training aid for new employees and as a reference for all personnel who manufacture and maintain Digital products.

STATUS: APPROVED 01-Mar-1993; use VTX SMC for current status.

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1 INTRODUCTION

This standard provides the workmanship criteria to be applied in the manufacture and maintenance of Digital products that contain fully-assembled, printed-wiring boards. In addition, the workmanship criteria described applies to rework and repair activity. The results of all rework and repair must be equal to the quality of the original product.

2 LEVELS OF ACCEPTABLE AND UNACCEPTABLE WORKMANSHIP

The following levels of acceptability are used to describe workmanship conditions throughout this standard.

Optimal (Reference)

The nominal condition from which minimal acceptable and unacceptable variations are described.

Acceptable Minimum

The least degree of quality that will be accepted in Digital standards and engineering specifications.

Unacceptable

The level whereby a product that contains a critical or major defect must be either reworked to bring it to the acceptable condition or scrapped if it is not repairable. An exception to this is defined under subhead 2.1, Minor Defect.

NOTE

The above requirements shall prevail when specific information does not appear on engineering documentation. Engineering documentation may define specific quality requirements that take precedence over general workmanship standards.

2.1 LEVELS OF UNACCEPTABLE DEFECTS

The following levels of unacceptability are used to describe workmanship conditions throughout this standard.

Critical Defect

A critical defect is one that judgment and experience indicates could result in a potential hazard or unsafe conditions for individuals who are using, maintaining, or who are near a unit, assembly or system.

Critical defects must be reworked immediately to a safe condition or the potential hazard must be removed.

No product with a critical defect may move through the manufacturing process.

Major Defect

A major defect is one that results in failure or reduces, mechanically or electrically, the usability of the unit, assembly, or system for its intended purposes. The unit does or will fail for reasons of either form, fit, or function.

Minor Defect

A minor defect is one that judgment and experience indicates may or can cause a form, fit, or functional failure in the unit. Rework of this condition is not necessary if the customer will accept the unit with the defect.

2.2 Magnification and Lighting

Magnification tools and lighting used for inspection shall be commensurate with the size of the item being processed. The magnification used to inspect solder connections shall be based on the minimum width of the land used for the device being inspected. The following magnification shall apply.

Land Width	Inspection	Referee
>0.5 mm (>0.020 in)	1.75X-4X	10X
0.25 - 0.5 mm (0.010 - 0.020 in)	10X	20X
<0.25 mm (0.010 in)	20X	30X

Referee conditions shall only be used to verify product rejected at the inspection magnification. For assemblies with mixed land widths, the greater magnification may be used for the entire assembly.

The tolerance for magnification aids is 15 percent of the selected magnification power. For example, ± 15% or range of 30% centered at the selected magnification power.

NOTE

Illustrations in this standard are intended to depict only the criteria as listed for each. Other conditions may be present in the picture, but should not be considered unless specifically described.

3 DEFINITIONS

The following are definitions for terminology used throughout this document that relate to modules.

Access Hole	See Terminal Hole.
Adhesion	See Bond Strength.
Ambient Temperature	The room temperature of the surrounding area.
Artwork	An accurately scaled master configuration that is used to produce the printed-circuit pattern.
Base Laminate	The insulating support for printed-wiring or printed-circuits.
Base Material	The insulating material comprising the base laminate.
Blister Foil	A localized separation between the base material and the conductive material.
Blister Interlaminar	A void produced under the surface of laminated material which is a form of delamination.
Blow Holes	A void that is larger than the lead diameter. See also the definition of a void.
Board Thickness	The overall thickness of the base material and conductive material.
Bond Strength	A measure (in pounds per square in) of the force required to separate a layer of conductive material from the adjoining base by a perpendicular pull applied to the surface of the conductive material.
Bridging	The formation of an unwanted conductive path between conductors.
Bus Wire	A solid conductor used to connect two or more terminals. There are two types, insulated and noninsulated.
Clinched Lead	A component lead which is passed through the printed-circuit board and then bent.
Cold Solder Joint	A solder connection exhibiting poor wetting and a grayish, porous appearance due to insufficient heat, inadequate cleaning prior to soldering, or excessive impurities in the solder.
Component	Any electrical or mechanical device, such as a coil, resistor, capacitor, generator, integrated circuit, or transistor, having distinct electrical characteristics and having terminals at which it may be connected to other components to form a circuit, connector, fast tab, or switch.
Component Damage	Components that show visible evidence of physical imperfections of the body, leads, seal, and marking.
Component Lead	Solid or stranded, insulated or noninsulated wires or lead frame protruding from the body of the component.
Component Part	See Component.
Component Side	The side of a printed-wiring board upon which component parts are mounted (commonly referred to as side 1; opposite of soldered side).
Concave	Curved, like the inner surface of a sphere.
Conductive Foil	A form of conductive material (commonly referred to as etch) that covers one or both faces of the base material and the inner layers of multilayer boards.
Conductor	A single conductive line or area forming an electrical connection between terminal areas.
Conductor Layer	The layer of a printed-wiring board containing conductors.
Conductor Pattern	A pattern formed from any electrically conductive material on a base.
Connection	The means by which electrical contact is made to the conductive pattern.
Convex	Curved or rounded, like the exterior of a sphere.
Corrosive	A substance is considered chemically reactive or corrosive if it has the ability to degrade a conductive pattern electrically or mechanically.

Crazing	A condition existing in the base laminate in the form of connected white spots or crosses on or below the surface of the base laminate. This condition reflects the separation of fibers in the glass cloth and connecting weave intersection.
Cross-hatching	A design technique of the breaking up of large conductive areas by use of a pattern of voids in the conductive material to reduce board warpage.
Delamination	The separation of printed board material within the laminates.
Dents	Depressions in the copper foil or component which do not significantly decrease the thickness of the copper foil or function of the component.
Dewetting	Characterized by solder not completely covering the surfaces to be bonded. Solder may appear as droplets or balls having withdrawn from previously wet adjacent areas.
Disturbed Joint	A joint in which the lead or part has moved while the solder was solidifying. This joint will have a dull, granular appearance or noticeable cracks.
Double Sided Board	A printed board with conductive material on both sides of the board.
Dross	Oxide and other contaminants which form on the surface of molten solder.
Etch	See Conductive Foil.
Eutectic Alloy	An alloy of metals so proportioned that all the metals in the alloy have a specific melting point rather than a range, thus, possessing the characteristic of passing from a liquid state to a solid without the intermediate plastic formation. Eutectic solder is 63 percent tin and 37 percent lead.
Feed Through	See Interfacial Connection.
Fiber Exposure	A condition in which broken glass cloth fibers are exposed in machined or abraded areas.
Fillet	A smooth transition of solder between the parts being joined.
Finger	See Printed Edge Board Contacts.
Flux (Rosin)	A chemically active agent that speeds the wetting process of metals with molten solder. When heated, flux will remove oxides, but it will not remove oils, dirt, or fingerprints (only a solvent can remove these three things).
Fractured Joint	A solder joint where the lead has separated from the solder connection more than 180 degrees on either side 1 or side 2 of the plated-through hole (PTH). Also identified as a disturbed solder joint with a dull, granular appearance or noticeable cracks.
Granular Solder	Solder appearance with a coarse, large grain structure, lacking in metallic luster.
Icicle	See Solder Projection.
Interfacial Connection	The electrical connection between conductive patterns on parallel layers of the circuitry. (May be an eyelet, griplet, or plated through-hole (PTH) but may not contain a component lead.)
Jumper	A direct electrical connection between two points on a printed board added after the printed-wiring is fabricated. (A jumper consists of bus wires.)
Land	See Terminal Area.
Lead Peel Back	A solder joint that exhibits good wetting characteristics, where the lead has been mechanically separated by not more than 180 degrees, or half the circumference of the lead. For lead peel back, the lead must show evidence of being manually cut.
Legend (Marking)	Lettering or symbols indicating part numbers, component locations, and so on.
Measling	A condition existing in the base laminate in the form of discrete white spots or crosses below the surface of the base laminate. This reflects a separation of fibers in the glass cloth at the weave intersection.
Meniscus	Component coating that has run down the component lead (pant legs).

Module/Module Assembly	A printed-wiring board with components attached that is used primarily to interconnect various types and configurations of components to make a functional device.
Mounting Hole	A mounting hole is a hole used for mechanical mounting of a printed board to the chassis or for mechanical attachment of components to the board. (Also referred to as the Access Hole.)
Multilayer	A printed-wiring board consisting of two outer layers of circuitry and at least one additional conductive layer in between the outer layers.
Nonwetting	A condition whereby a surface has contacted molten solder, but has had none of the solder adhere to it.
Oxidation	A form of contamination which prevents proper solder wetting.
Pad	See Terminal Area.
Pin Holes	A void that is smaller than the lead diameter. See also the definition of a void.
Plated-through Holes (PTH)	An interfacial or interlayer connection consisting of a layer of conductive material on the sides of a hole through the base material.
Plating	The process consisting of the chemical or electrochemical deposition of metal on all or part of the conductive pattern.
Polarizing Slot	The slot in the edge of a painted board used to assure proper insertion and location in a mating connector (commonly referred to as the notch or key).
Post-baking	The baking of module after wave solder to reduce warpage.
Pre-baking	The baking of a printed-wiring board prior to wave solder or mass reflow process to remove moisture.
Preheating	An intermediate heating operation used to raise the temperature of the work above room temperature (ambient) to activate the flux and reduce the thermal shock of an elevated temperature processing operation such as wave soldering.
Printed-circuit	A pattern composed of printed-wiring or circuitry formed on a common rigid or flexible base.
Printed-circuit Assembly	A printed-wiring board on which separately manufactured component parts have been added (commonly called a module).
Printed-circuit Board (PCB)	A completely processed conductive pattern ready for assembly.
Printed Edge Board Contact	The portion of printed-wiring or circuitry used for the purpose of providing external electrical connection to a PCB by pressure contact and is usually gold plated.
Printed-wiring	See Conductor.
Printed-wiring Assembly	See Module.
Printed-wiring Board	See Printed-circuit Board.
Residue	Substance remaining on a module after soldering and cleaning, such as flux or oil.
Rosin	A type of flux.
Rosin Connection	A layer of solidified flux creating an interface between the conductors having no metallic or electrical continuity thereby resulting in a high resistant condition with a low strength factor.
Scorch	To overheat a surface of a printed-wiring board so as to change its color and texture.
Side 1	Typically the component side of the printed-wiring board/assembly and is also referred to as layer 1.
Side 2	Typically the soldered side of the printed-wiring board/assembly also known as layer-n of an n-layered board. (n = number of layers).
Single Sided Board	A printed board with etches on Side 2 only.
Solder	Ordinary soft solder is a fusible alloy consisting of essentially tin and lead used for the purpose of joining together two or more metals at temperatures below their respective melting points.

Solderability	The measure of the ability of a metal surface to be wetted by solder.
Solder Impurities	The contaminants that appear in a solder bath during usage which may degrade the quality of the finished solder joint.
Soldering	A process whereby materials are brought in contact with the surface of a static pool of molten solder for the purpose of soldering the entire exposed conductive pattern in one operation.
Solder Masking	An epoxy coating usually applied to Side 2 (solder side) of a module to eliminate solder shorts between circuit runs during wave solder and repair operations. Solder mask must never be on a pad or in a plated-through hole into which a component will be inserted.
Solder Paste (Cream)	Solder particles of specified size combined with additives to promote wetting and to control viscosity, tackiness, slumping, drying rate, and so on.
Solder Paste Flux	A nonmetallic element of solder paste.
Solder Projection	Solder (spike-like) protruding from a solidified solder joint or etch commonly called an icicle.
Solder Splashes	Drops, balls, or flakes of solder in areas that should be free of solder.
Surface Mounting	The electrical connection of components to the surface of a conductive pattern without utilizing component holes.
Tack Soldering	The method of fastening a component lead or wire to a component lead, etch, or contact finger by soldering.
Terminal Area	The portion of a printed-wiring or wiring used for making electrical connections to the conductive pattern or component.
Terminal Hole	A hole within a terminal area.
Terminal Pad	See Terminal Area.
Tinning	The process of coating conductive paths or terminals with solder for the purpose of decreasing in-process oxidation and improving their solderability.
Twist	A bending or curving distortion from a true or plane surface in a direction parallel to a diagonal of the printed-wiring board/module assembly.
Unplated Hole	A hole containing no conductive material in a printed-wiring board.
Void	The area of absence of a specific metal from a certain area. Voids, such as pin holes or blow holes, result from the formation of gas pockets in the PTH during soldering. The gas may be from the flux solvents or from the materials being soldered.
Warp	The deviation from flatness of a board characterized by a roughly cylindrical or spherical curvature parallel to the major or minor axis of the printed-wiring board.
Wave Soldering	A process whereby printed boards are brought in contact with the surface of a standing wave of molten solder.
Weave Exposure	A condition in which the unbroken woven glass cloth is not uniformly covered by resin at the board surface.
Wetting	The free flow and spreading of solder on conductive paths and terminals to form an intermetallic bond.
Whisker	A microscopic, metallic sliver that can cause an electrical connection between adjacent conductors.
Wicking	Drawing up of solder through capillary action, through a hole or up a wire.

4 BURNT/SCORCHED

The following information describes burnt or scorched print-wiring boards.

4.1 Burnt

A burn is a discoloration of a printed-wiring board or assembly caused by excessive heat. Printed-wiring boards that exhibit delamination as a result of burns are not acceptable.

4.2 Scorched (Discoloration)

Printed-wiring boards that are subjected to heat severe enough to cause discoloration and surface roughness of the base laminate shall be considered unacceptable.

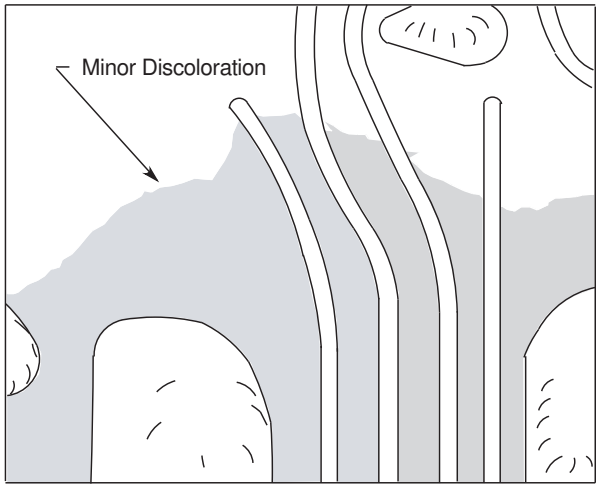
4.3 Optimal (Reference)

The optimal (reference) condition is when the printed-wiring board does not exhibit discoloration from severe heat.

4.4 Acceptable Minimum

Minor discoloration, regardless of the area it covers, is acceptable provided that there is no indication of delamination, measling, charring, blistering, or lifting of circuit foil. See Figure 1 and *EL-MF116-01, Module Assembly Workmanship Photographs*, Photograph 1-1.

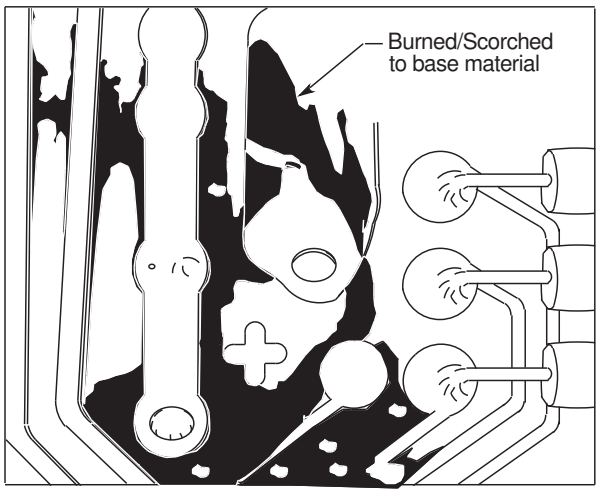
Figure 1: Acceptable Minimum: Burnt/Scorched



4.5 Unacceptable

The printed-wiring board exhibits burns and delamination to the base material. See Figure 2 and *EL-MF116-01*, Photograph 1-2.

Figure 2: Unacceptable: Burned/Scorched



5 DELAMINATION

Delamination is recognized by a blistering effect in the base laminate. No more than one blister per 64.4 cm^2 (10 $inch^2$) is acceptable.

5.1 Optimal (Reference)

No blistering or separation between fiber layers is the optimal (reference) condition.

5.2 Acceptable Minimum

The following information describes acceptable minimum conditions for delamination on printed-wiring boards.

1. Blister not larger than 9.52 mm (0.375 in) in any dimension and no closer than 6.35 mm (0.250 in) to any circuitry pad, plated-through hole, or the finished edge of the module.
2. No more than one blister per 64.4 cm^2 (10 $inch^2$)

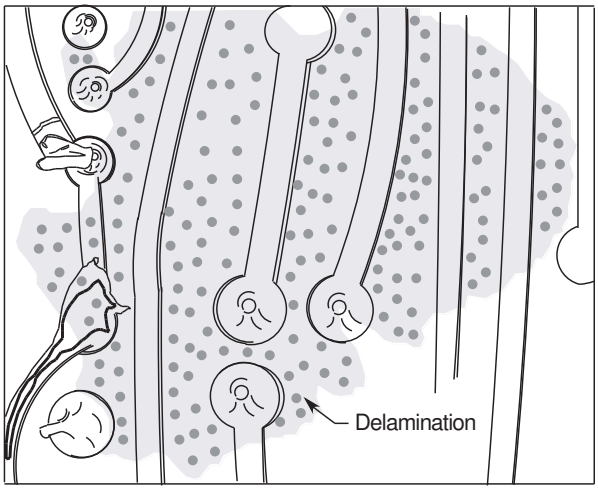
5.3 Unacceptable

Major Defect

The following information describes unacceptable conditions. See Figure 3 and *EL-MF116-01*, Photograph 1-3.

1. Blistering is evident in the laminate or in the area of the circuitry.
2. More than one blister per 64.4 cm^2 (10 $inch^2$) of the module.

Figure 3: Unacceptable: Delamination



6 MEASLING AND CRAZING

The following information describes measling and crazing conditions.

6.1 Measling

Measling is a condition existing in the base laminate in the form of discrete white spots or crosses below the surface of the base laminate, reflecting a separation of fibers in the glass cloth at the weave intersection. Measling is not electrically degrading and is generally acceptable. Only in extreme cases shall measling be considered unacceptable.

6.2 Crazing

Crazing is described as a condition existing in the base laminate in the form of connected white spots or crosses on or below the surface of the base laminate. This reflects the separation of fibers in the glass cloth and connecting weave intersections.

6.3 Optimal (Reference)

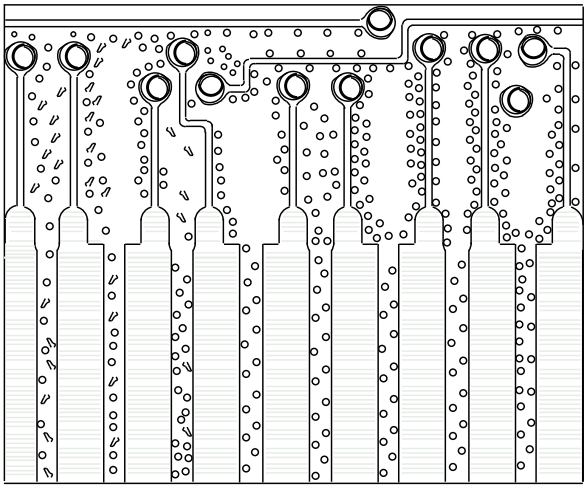
No weave exposure or areas of delamination is the optimal (reference) condition.

6.4 Acceptable Minimum

The following information describes acceptable minimum conditions for measling and crazing on printed-wiring boards.

1. Weave exposure not adversely affecting the mechanical or electrical properties of the base laminate. See Figure 4 and *EL-MF116-01*, Photograph 1-4.
2. Measling bridging several conductors.
3. Crazing that does not go under conductors or is adjacent to conductors.

Figure 4: Acceptable Minimum: Measling and Crazing



6.5 Unacceptable

Major Defect

The following information describes unacceptable measling and crazing conditions.

1. Severe measling and delamination is evident. See *EL-MF116-01*, Photograph 1-5.
2. Crazing that appears under conductors.

7 CONTAMINATION and CLEANING

The following is information about contamination and cleaning of printed-wiring boards.

1. Contamination by any foreign material that may affect surface resistivity of the printed-wiring assembly is not acceptable.
2. Foreign material shall be removed by thorough cleaning. Particular care shall be taken to eliminate the following:

   metal chips
   filings
   clippings
   salt (food residue)
   wire strands
   flux concentrations (except nonclean residue)
   rosin flakes
   loose terminals
   solder splashes
   tape residue
   temporary solder mask
   liquid mask

NOTE

Refer to *EL-MF299-00, Printed-Circuit Boards/Modules: Cleaning Process Contamination,* for additional information on cleaning contamination and how to control ionic contamination lead within the module assembly process.

7.1 Optimal (Reference)

The optimal (reference) condition is when the board is clean of residue or contaminates.

7.2 Acceptable Minimum

The following information describes acceptable minimum conditions.

1. Wax from capacitors on the module, provided it is not in the area of the contact fingers or connectors, is acceptable.
2. Small quantities of thermal compound are acceptable on a module provided it is no more than 1.59 mm (0.063 in) from the component (containing compound) and it does not contact another circuit.
3. Flux residue from qualified no-clean fluxes are acceptable on modules provided they are not on contact areas. Examples of contact areas include contact fingers or pads.

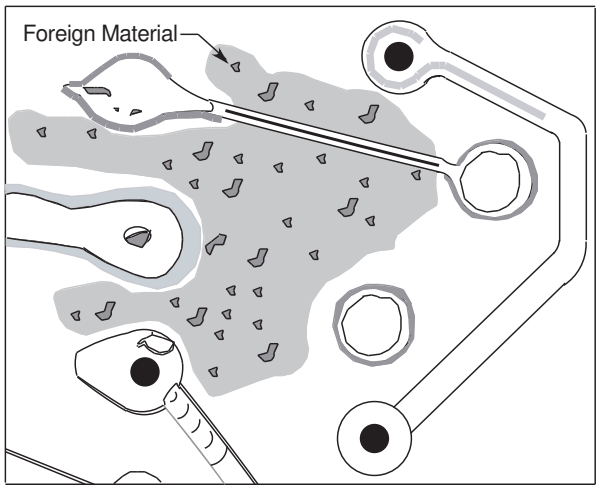
7.3 Unacceptable

Major Defects

The following information describes unacceptable conditions for contamination on printed-wiring boards.

1. Board has solder or other foreign material embedded in the flux. See Figure 5 and *EL-MF116-01*, Photograph 1-6.
2. Board has wax or white residue on the contact fingers (see note).
3. Module has large amounts of thermal compound in the contact finger area or in contact with adjacent component or etch.

Figure 5: Unacceptable: Contamination



NOTE

If white residue appears on the board, further evaluation is required. If the residue is water soluble, it must be removed. If it is not water soluble, it does not have to be removed, provided it is not in the area of the contact fingers or in contact with an adjacent component or etch.

8 CONTACT FINGER AND ETCH (DAMAGE)

Scratches, chipping, peeling, voids or mars that extend into the base material and expose the copper and/or nickel plating are not acceptable in the critical contact area of the finger. For more information, refer to *DEC STD 176-0 Printed-Wiring Board Acceptance Criteria.*

8.1 Bridging

Conductive material that is bridging the contact finger at the beveled edge, or elsewhere on the contact fingers, is not acceptable.

8.2 Voids

The following information describes acceptable conditions for voids on contact fingers and etches.

1. One void no greater than 0.25 mm (0.010 in) on one contact with a maximum of three contacts per set (18 contacts) is acceptable in the critical contact area.
2. Two voids per contact, in the noncritical contact area, whose length, width, or diameter does not exceed 0.51 mm (0.020 in), or one void per contact, whose length, width, or diameter does not exceed 1.02 mm (0.040 in), with a maximum of 6 per set of contacts (18).

8.3 Optimal (Reference)

The following information describes optimal (reference) conditions for contact fingers.

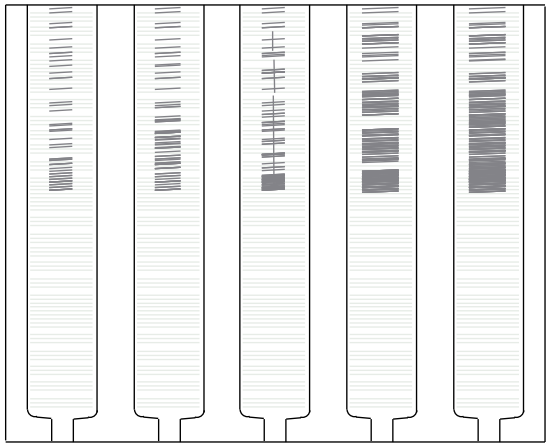
1. No damage or scratches on the contact fingers.
2. No pits or voids in the contact finger.

8.4 Acceptable Minimum

The following information describes acceptable minimum conditions for contact fingers.

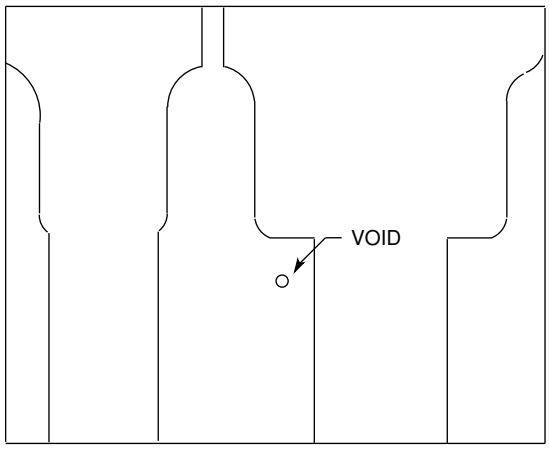
1. Damage in the critical area is slight and does not extend into the base metal exposing copper or nickel. See Figure 6 and *EL-MF116-01*, Photograph 1-7.

Figure 6: Acceptable Minimum : Contact Finger Voids - Critical Area



2. Voids meeting the criteria under subhead 8.2 shall be considered acceptable minimum. See Figure 7 and *EL-MF116-01*, Photograph 1-8, for an example of a void in the noncritical contact area.

Figure 7: Acceptable Minimum : Contact Finger Voids - Noncritical Area



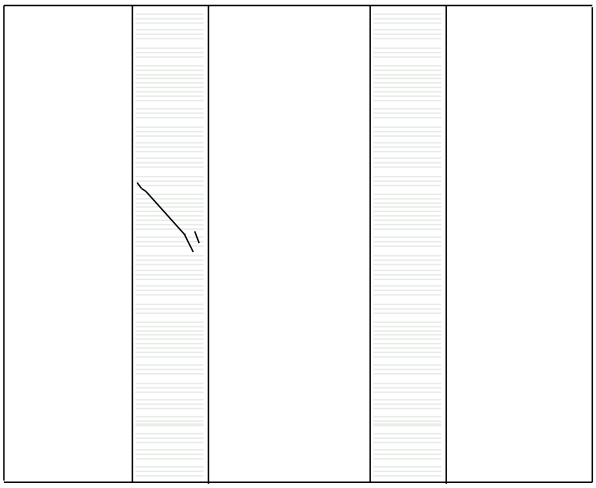
8.5 Unacceptable

Major Defects

The following information describes unacceptable conditions for damaged contact fingers.

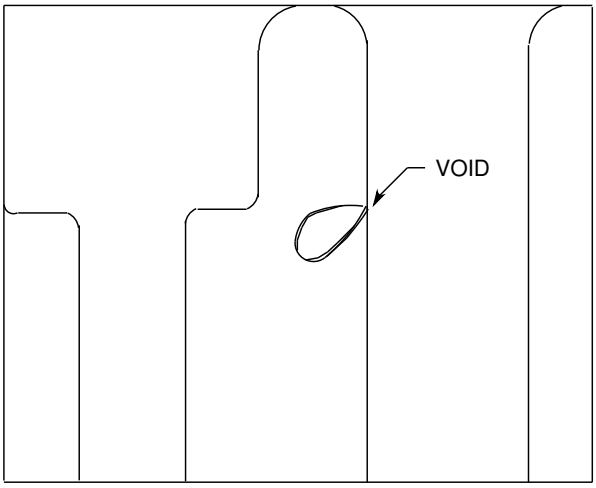
1. Deep scratches in the plating extending into the base material and exposing copper or nickel plating. See Figure 8 and *EL-MF116-01*, Photograph 1-9.

Figure 8: Unacceptable: Contact Finger Damage



2. Voids exceeding the criteria described in subhead 8.2 are unacceptable. See Figure 9 and *EL-MF116-01*, Photograph 1-10, for examples of excessive voids in the noncritical contact area.

Figure 9: Unacceptable: Contact Finger Voids



3. Contact finger is curled at the beveled edge.
4. Flaring of the contact fingers at the beveled edge of the board.

Minor Defect

Nicks, scratches, pits, dents and voids are acceptable on etch lines provided there is no exposed copper or nickel on the surface; edges may be exposed.

NOTE

Boards shall not be rejected for missing unused fingers.

9 MODULE IDENTIFICATION AND MARKING

All markings shall be legible, uniform in height, size, and a color that is in contrast to the finish on which it is applied. Markings using stamp and ink application must be applied with indelible ink. All identifying markings such as acceptance stamps, assembly numbers, date codes, module revision levels, etch revision levels, and module types shall be complete and readable.

9.1 Optimal (Reference)

Marking is distinct and complete.

9.2 Acceptable Minimum

Marking is smudged but readable. See Figure 10 and *EL-MF116-01*, Photograph 1-11.

Figure 10: Acceptable Minimum: Module Identification and Marking

9.3 Unacceptable

Minor Defect

Marking is unreadable or incomplete. See Figure 11 and *EL-MF116-01*, Photograph 1-12.

Figure 11: Unacceptable: Module Identification and Marking

10 GRIPLETS

The following information describes acceptable and unacceptable conditions for griplets.

1. Griplets without component leads (feed through griplets) must display a complete solder fillet to at least one-third of the petals of the griplet on side 1 and side 2.
2. For griplets with component leads to be installed, a minimum of two-thirds of the griplet must have a solder fillet (side 1 and side 2 of the module).
3. Petals cannot lie flat against the board. See Figure 12.

NOTE

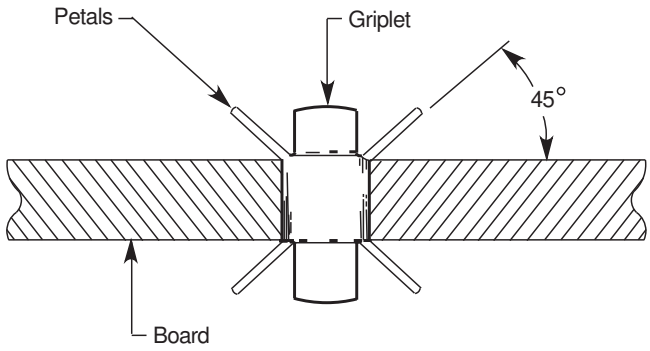
Griplets are not to be used on any multilayer/high density or fineline modules.

10.1 Optimal (Reference)

The following information describes optimal (reference) conditions for griplets.

1. Griplet petals are staked symmetrically with all petals intact and 45 degrees from the board. See Figure 12.
2. Complete wetting on side 1 and side 2.

Figure 12: Optimal (Reference): Griplets

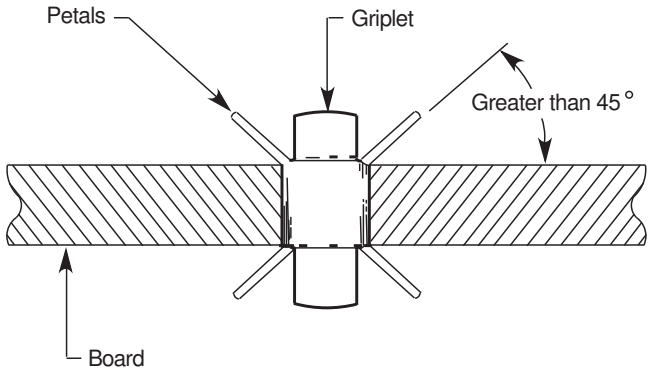


10.2 Acceptable Minimum

The following information describes acceptable minimum conditions for griplets.

1. Petals are incorrectly bent. See Figure 13.
2. Two-thirds of the griplet exhibits good wetting action.
3. One-third of the petals are missing.

Figure 13: Acceptable Minimum: Griplets



10.3 Unacceptable

Minor Defect

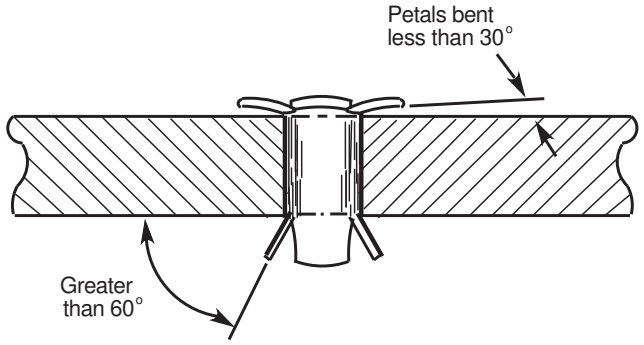
Petals are bent less than 30 degrees or greater than 60 degrees from the circuit board. See Figure 14.

Major Defects

The following information describes unacceptable major defects for griplets.

1. Two-thirds of the petals are missing (griplets containing leads).
2. Griplet not completely through the module.

Figure 14: Unacceptable: Griplets



11 WIRE DRESS AND BONDING

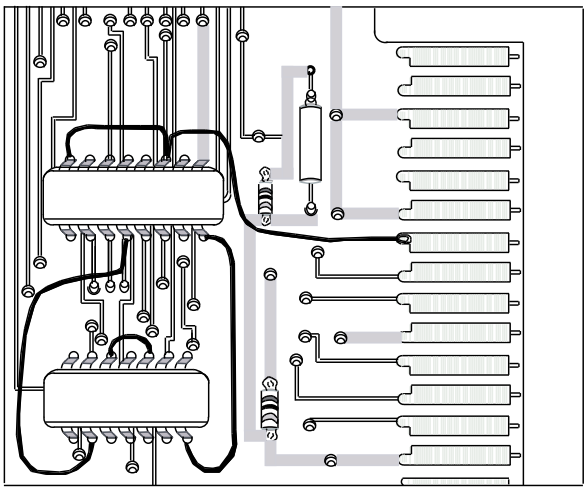
Wire applied to printed-wiring boards shall meet the following criteria.

11.1 Wire Dress

The following information describes acceptable and unacceptable conditions for wire dress.

1. Wire dress shall be neat and uniform. Wires should have rounded corners and not sharp, squared corners. Wire bend radius shall be at least three times the diameter of the conductor. See Figure 15 and *EL-MF116-01*, Photograph 1-13.

Figure 15: Wire Dress



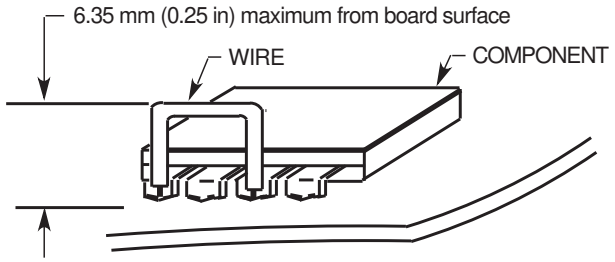
2. Wires on modules should not come in contact with component leads or body. Wires should not run over, under, or in contact with components, except at points of connection.
3. There shall be no wire insulation extending into the plated through-hole or into the soldered connection.
4. Insulation strip-back should be such that no shorting to adjacent leads, etches, or pads exists.
5. Wires shall be routed to be as short as possible unless otherwise specified in engineering drawings.
6. Wires should be placed no closer than 6.35 mm (0.25 in) from the finished edge of board on plug-in type modules only.

11.2 Wire Bonding

The following information describes acceptable and unacceptable conditions for wire bonding.

1. Wires should be sufficiently bonded to prevent them from lifting no more than 6.35 mm (0.25 in) from the board surface. Wires 12.70 mm (0.50 in) or less do not need to be bonded. See Figure 16.

Figure 16: Wire Bonding



2. Adhesive should not be allowed to flow in contact with any surface component lead, pad, or circuit which will later be required to accept solder.

11.3 Optimal (Reference)

Wires are tack bonded with no squared corners and no insulation in the soldered connection.

11.4 Acceptable Minimum

If a wire is in contact with a component lead or body but shows no evidence of deformation of the insulation, and the component is nonheat dissipating, then rework is not required. Examples of nonheat dissipating components are passive and plastic devices.

11.5 Unacceptable

Minor Defect

Wire bend radius is less than 3 times the diameter of the conductor.

Major Defects

The following information describes unacceptable major defects.

1. Wires that exceed 6.35 mm (0.250 in) above the board surface.
2. Wires that have nicked insulation and are in danger of shorting to an etch or component lead.
3. Wire insulation in the plated through hole or in the soldered connection.

12 LIFTED PADS/CONDUCTORS (SIDE 1 AND 2)

The following are acceptable and unacceptable conditions for lifted pads and conductors.

12.1 Lifted Pads Without Attached Conductors

Pads lifted less than 50 percent and soldered shall be considered acceptable when they exhibit good wetting of component lead-to-pad. Three lifted pads per 10 square inches is allowed. See Figure 17.

Figure 17: Lifted Pads

1. Component Hole
2. 50% of pad that is secure.
3. 50% of pad that is lifted.

Pads Without Attached Conductors

Pads With Attached Conductors

12.2 Pads With Attached Conductors

Lifted pads with attached conductors shall be considered acceptable provided that the lifted area does not exceed 50 percent of the pad and the lifting of the pad does not occur at the conductor junction. See Figure 18 and *EL-MF116-01*, Photograph 1-14. The attached conductor cannot be lifted or damaged. See Figure 19 and *EL-MF116-01*, Photograph 1-15.

Figure 18: Acceptable Minimum: Lifted Pads With Attached Conductors

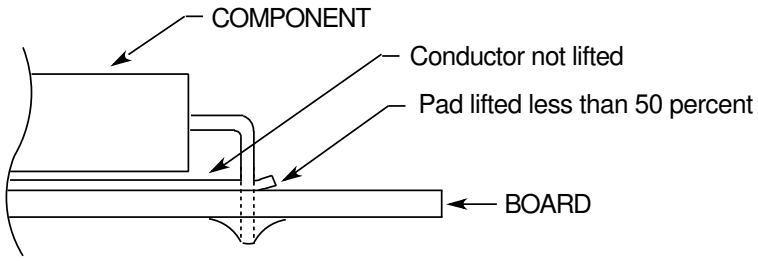
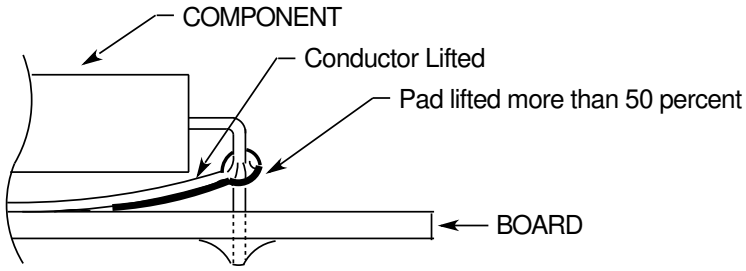


Figure 19: Unacceptable: Lifted Pads With Attached Conductors



12.3 Missing Pads Without Attached Conductors

The following information describes acceptable and unacceptable conditions for pads without attached conductors.

1. Boards with missing pads shall be considered acceptable when the quantity does not exceed 10 percent of the number of holes in a component pattern. For example, one missing pad on each side of the board in a 14 pin intergrated circuit (IC) pattern is acceptable.
2. Any measling, crazing, or delamination that causes pads or conductors to lift away from the printed-wiring board surface is unacceptable.

NOTE

"Attached Conductors" shall include only conductors attached on the same side as the pad in question. The plated-through hole must exhibit good solderability.

13 BOARD WARPAGE (BOW AND TWIST)

Bow and twist after soldering shall not exceed 1.5 percent for through-hole and mixed technology, or 75 percent for surface-mount printed board applications. Bow and twist shall not be sufficient to cause difficulties during post-solder assembly operations.

13.1 Measurement Procedure

Refer to section 2.4.22 of *ANSI/IPC-TM-650, Test Methods Manual* for information on this subject.

13.2 Measurement Formula

The following is the formula to be used when measuring board warpage.

```
Deviation
------------  X 100 = % Warpage
Board Length
```

14 COMPONENT LEAD DAMAGE

Component leads that are nicked, cut, dented, flattened or deformed where the cross sectional area of the lead has been reduced more than 25 percent are unacceptable.

14.1 Optimal (Reference)

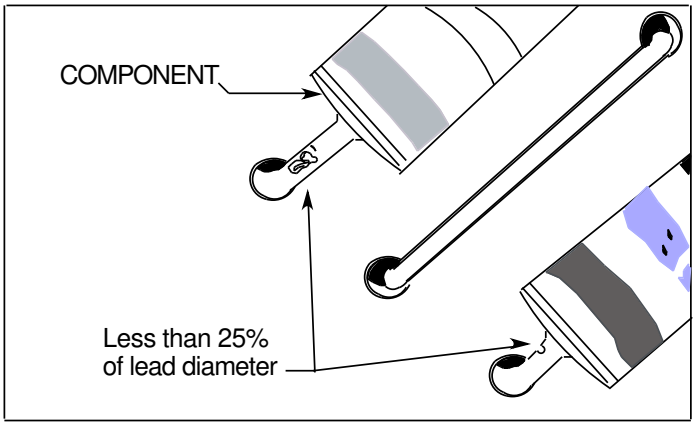
No lead damage.

14.2 Acceptable Minimum

The following information describes acceptable minimum conditions. See Figure 20 and *EL-MF116-01*, Photograph 1-16.

1. Slight deformation, less than 25 percent of the lead diameter.
2. Exposed copper on component leads on side 1 and side 2 is acceptable on assembled modules.

Figure 20: Acceptable Minimum: Component Lead Damage

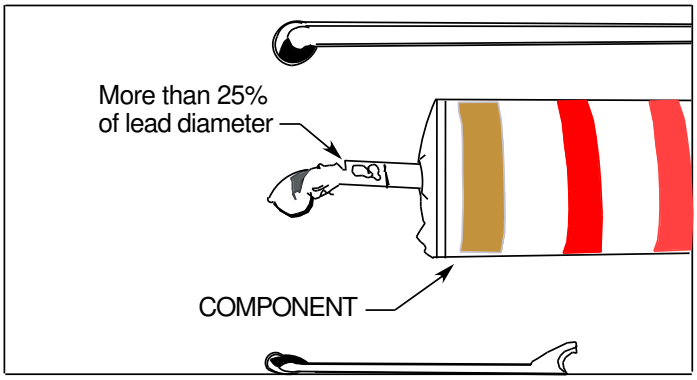


14.3 Unacceptable

Major Defect

Damaged leads affecting more than 25 percent of the lead diameter. See Figure 21 and *EL-MF116-01*, Photograph 1-17.

Figure 21: Unacceptable: Component Lead Damage



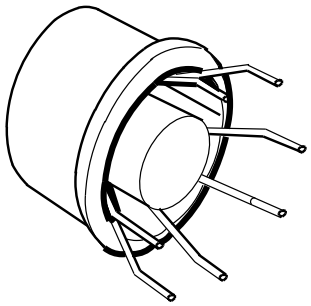
15 COMPONENT LEAD DRESS

Multilead components with three or more leads shall have their preformed leads extend out symmetrically from the center so that the orientation tab is correct. Component leads should extend out symmetrically and should bend to maintain a minimum of 0.79 mm (0.031 in) between lead and case.

15.1 Optimal (Reference)

Leads extend symmetrically from center. See Figure 22.

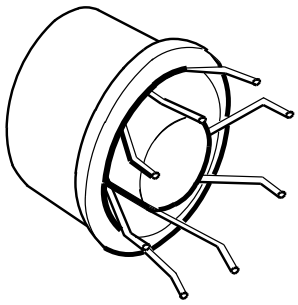
Figure 22: Optimal (Reference): Component Lead Dress



15.2 Acceptable Minimum

Leads extend symmetrically but with minor twist to leads. Tab orientation has been maintained. See Figure 23.

Figure 23: Acceptable Minimum: Component Lead Dress



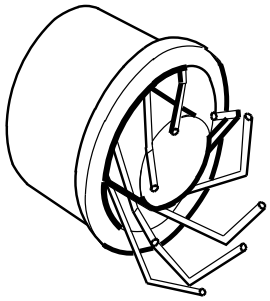
15.3 Unacceptable

Major Defects

The following information describes unacceptable major defects.

1. Twisted, crossed leads which do not allow correct tab orientation are unacceptable. See Figure 24.
2. Legs bent under component are unacceptable.

Figure 24: Unacceptable: Component Lead Dress



16 COMPONENT LEAD FORMING (AXIAL LEADS)

The following information describes acceptable and unacceptable conditions for forming leads prior to installation.

16.1 Bend Location

The lead of a component should extend straight out from the body a minimum of one lead diameter prior to the start of the bend. The lead should then pass through the board perpendicular to the board surface.

16.2 Bend Radius

The minimum inside bend radius of a component lead shall be one lead diameter and the maximum shall be 3.17 mm (0.125 in). The component lead should not be bent at an acute right angle (90 degrees).

NOTE

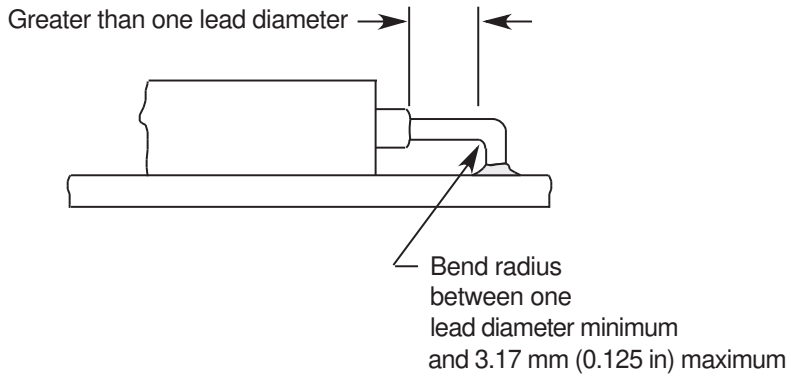
The end of the component body is defined to include any solder seal or weld bead (as on tantalum capacitors) or any other extension.

16.3 Optimal (Reference)

The following information describes optimal (reference) conditions for lead forming.

1. Lead bend is greater than one lead diameter from the body of the component.
2. Bend radius of the lead is between one lead diameter minimum and 3.17 mm (0.125 in) maximum. See Figure 25.

Figure 25: Optimal (Reference): Lead Forming

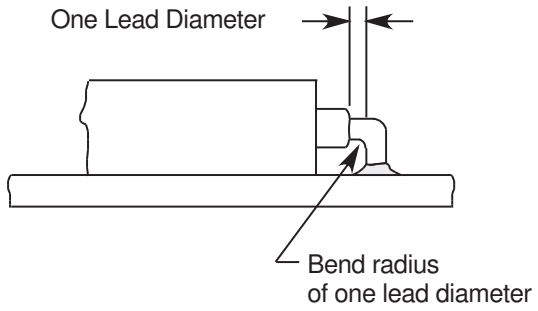


16.4 Acceptable Minimum

The following information describes acceptable minimum conditions.

1. Lead bend is a minimum of one lead diameter.
2. Bend radius of the component lead is at a minimum of one lead diameter or at a maximum of 3.17 mm (0.125 in). See Figure 26.

Figure 26: Acceptable Minimum: Lead Forming

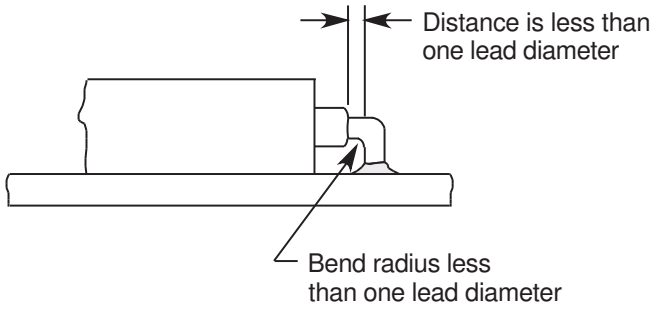


16.5 Unacceptable

Major Defect

Lead is bent less than one lead diameter from the body of the component. See Figure 27.

Figure 27: Incidental Defect: Lead Forming



NOTE

0.01 μF glass capacitors do not meet the criteria described in this section. They shall be closely inspected for damage to the components. The Digital part number for the 0.01 μF glass capacitor is 10-01610-00.

17 COMPONENT/WIRE LEAD PROTRUSION (SIDE 2, CLINCHED AND UNCLINCHED)

Component leads must be long enough to extend through the printed-wiring board. There must be evidence of the component lead on side 2 of the printed-wiring board. The protrusion of the lead shall be a maximum of 1.59 mm (0.063 in) on side 2 of the standard plug-in and nonplug-in printed-wiring boards (12.7 mm (0.50 in) backplane spacing). For nonstandard plug-in printed-wiring boards, lead length should be as stated in applicable engineering drawings.

17.1 Unclinched Leads

The following information describes acceptable and unacceptable conditions for unclinched leads.

17.1.1 Optimal (Reference)

Lead protrusion on side 2 of a module is visible in the solder fillet as a minimum (see Figure 28) and 1.59 mm (0.063 in) maximum (see Figure 29).

Figure 28: Optimal (Reference): Unclinched Leads

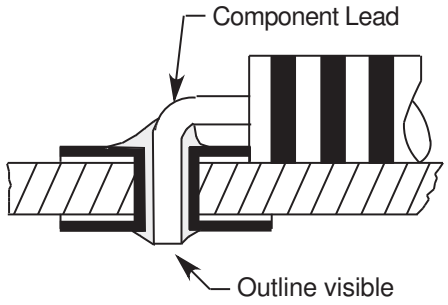
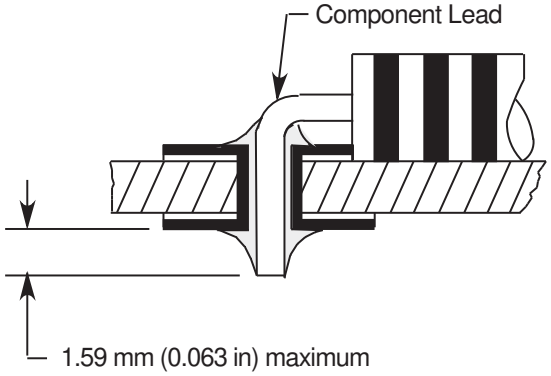


Figure 29: Acceptable Minimum: Unclinched Leads

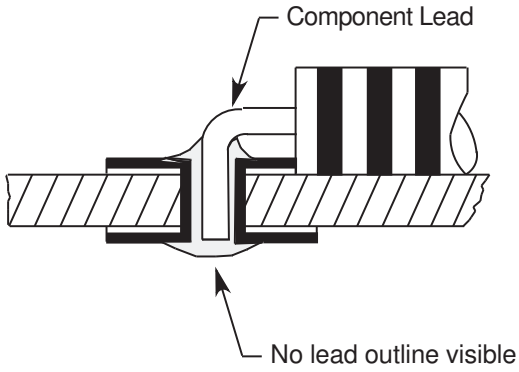


17.1.2 Unacceptable

Minor Defect

No evidence of lead outline visible. See Figure 30.

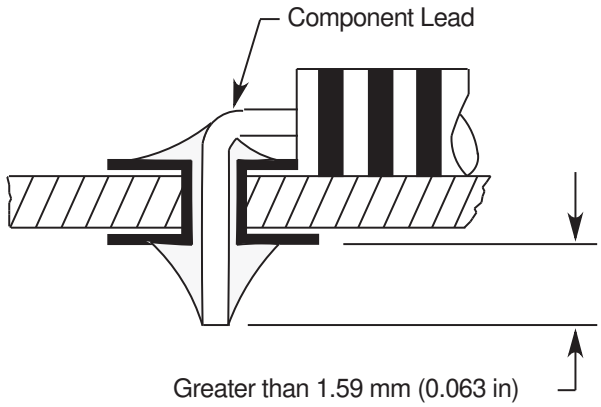
Figure 30: Unacceptable (Minor Defect): Unclinched Leads



Major Defect

Lead protrusion greater than 1.59 mm (0.063 in). See Figure 31.

Figure 31: Unacceptable (Major Defect): Unclinched Leads



17.2 Clinched Leads

The following information describes acceptable and unacceptable conditions for clinched leads.

17.2.1 Optimal (Reference)

Lead protrusion on side 2 of a module is visible in the solder fillet as a minimum (see Figure 32) and 1.59 mm (0.063 in) maximum (see Figure 33).

Figure 32: Optimal (Reference): Clinched Leads

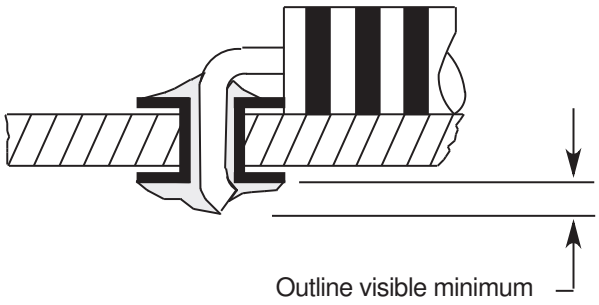
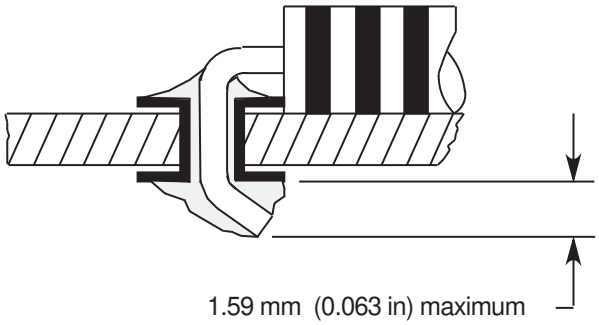


Figure 33: Acceptable Minimum: Clinched Leads

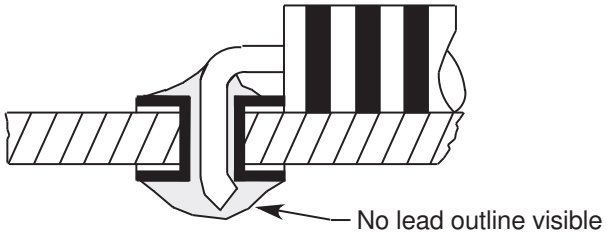


17.2.2 Unacceptable

Minor Defect

No evidence of lead outline visible. See Figure 34.

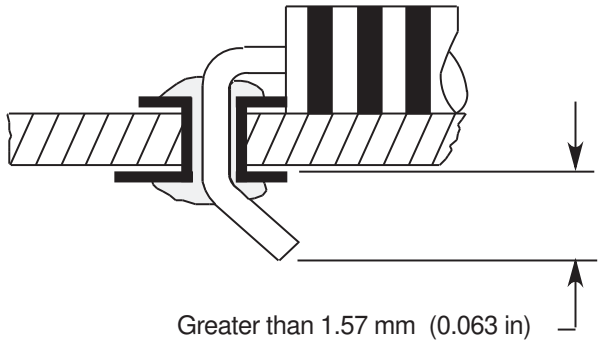
Figure 34: Unacceptable (Minor Defect): Clinched Leads



Major Defect

Lead protrusion is greater than 1.59 mm (0.063 in). See Figure 35.

Figure 35: Unacceptable (Major Defect): Clinched Leads



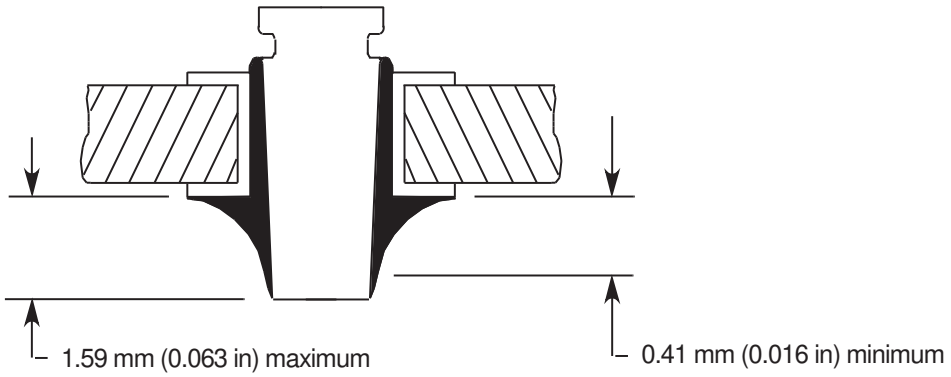
17.3 Socket Lead Protrusion

The following information describes acceptable and unacceptable conditions for lead protrusion on sockets.

17.3.1 Optimal (Reference)

Lead protrusion on side 2 of a module is within 0.41 mm (0.016 in) minimum and 1.59 mm (0.063 in) maximum. See Figure 36.

Figure 36: Optimal (Reference): Socket Lead Protrusion

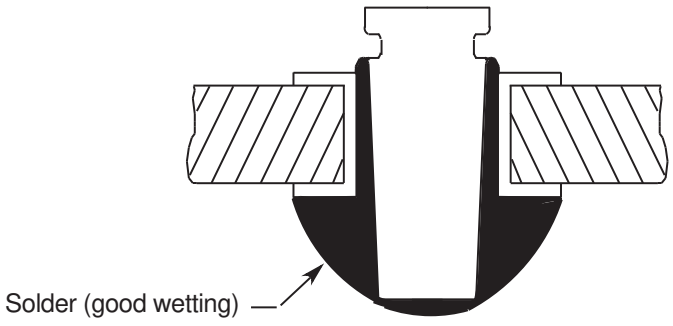


17.3.2 Acceptable Minimum

The following information describes acceptable minimum conditions for socket lead protrusion.

1. No evidence of lead outline visible.
2. Solder may overhang the pad.
3. Seating plane on component side is properly maintained and solder fillet exhibits good wetting. See Figure 37.

Figure 37: Acceptable Minimum: Socket Lead Protrusion



17.4 Lead Protrusion - Components with Premanufactured Fixed Lead Lengths (Connectors, Sockets, and Pin Grid Arrays (PGAs))

Components with premanufactured fixed lead lengths, such as edge connectors, sockets, and Pin Grid Arrays (PGAs), shall meet the following requirements.

1. Minimum length - end is visible in the solder joint
2. Maximum length (provided there is no danger of violating electrical spacing requirements) - 2.54 mm (0.100 in)

NOTE

The occasional lead(s) may exhibit a "domed" solder condition while adjacent leads exhibit acceptable length and soldering. This condition is acceptable and should not be rejected.

18 COMPONENT SLEEVING

Component leads shall be insulated (sleeved) if they are within 1.59 mm (0.063 in) of conductor surface or over 9.52 mm (0.375 in) in length from the component body to bend radius.

18.1 Insulation Sleeving

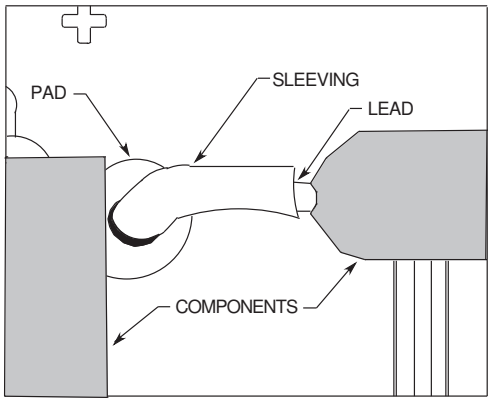
Insulation sleeving around a component body may be flexible plastic or heat shrinkable tubing. Component leads shall be insulated with teflon sleeving instead of flexible, plastic, or heat shrinkable tubing. Insulation sleeving shall be free of splits, tears, cuts, and burns.

18.2 Optimal (Reference)

The following information describes optimal (reference) conditions.

1. Lead is close to component case and is protected by sleeving. See Figure 38 and *EL-MF116-01*, Photograph 1-18.
2. Leads greater than 9.52 mm (0.375 in) that are sleeved.

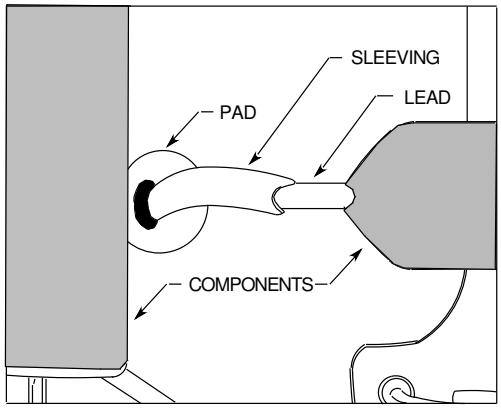
Figure 38: Optimal (Reference): Component Lead Sleeving



18.3 Acceptable Minimum

Length of sleeving is short, but even with movement, the sleeve covers enough of the lead to prevent shorting. See Figure 39 and *EL-MF116-01*, Photograph 1-19.

Figure 39: Acceptable Minimum: Component Lead Sleeving



18.4 Unacceptable

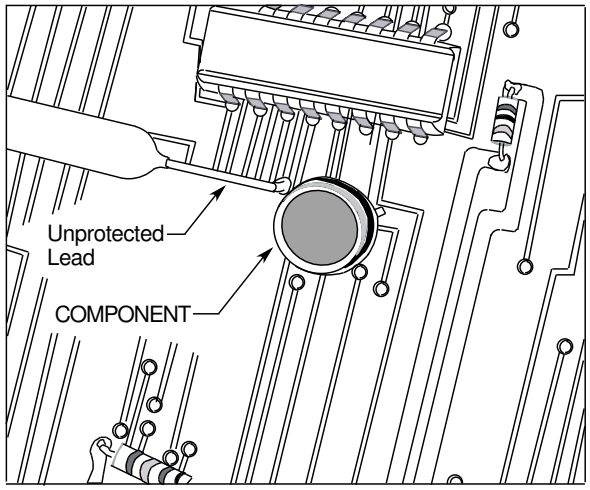
Major Defect

Unprotected lead in danger of shorting. See Figure 40 and *EL-MF116-01*, Photograph 1-20.

Minor Defect

Leads greater than 9.52 mm (0.375 in) that have no sleeving.

Figure 40: Unacceptable: Component Lead Sleeving



19 COMPONENT MOUNTING

The following information describes acceptable and unacceptable conditions for mounting components.

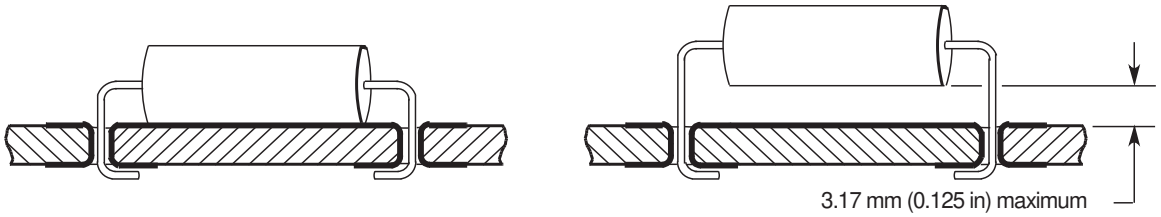
19.1 Height

The maximum height of any component mounted on a printed-wiring board shall meet product design requirements.

19.2 Horizontal Mounting

Horizontal mounting of axial lead supported components should be done so that their axis is parallel to the printed-wiring board. The component body should be in direct contact with the printed-wiring board for all insulated components. Horizontally mounted components shall not be bent or pressed to meet height requirements. See Figure 41.

Figure 41: Horizontal Mounting



NOTE

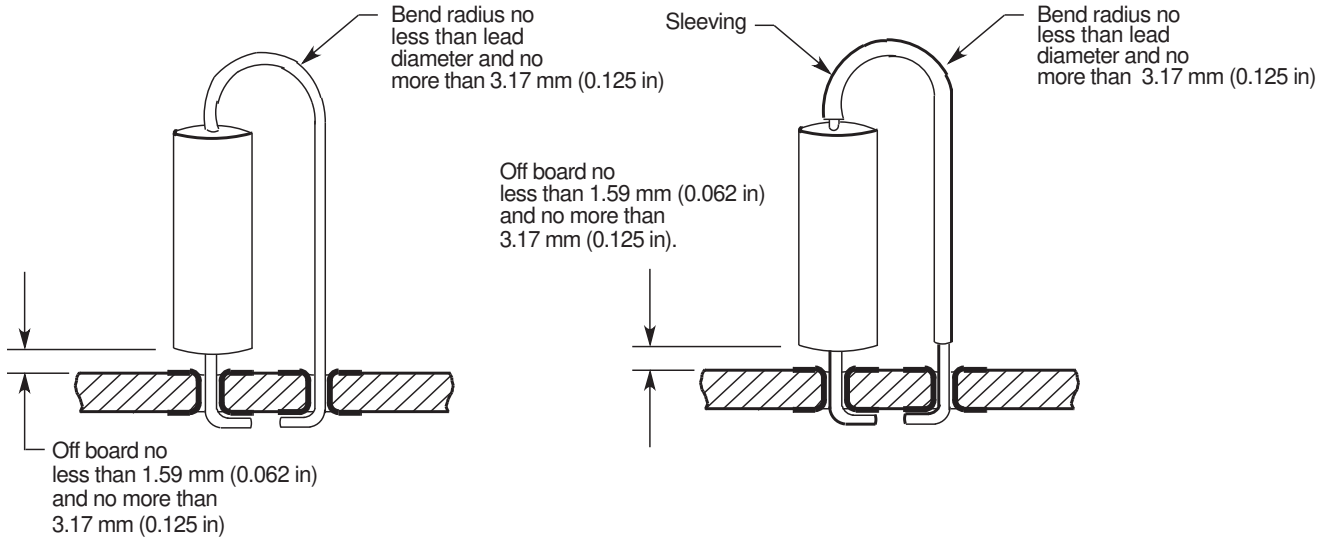
Although insulated components are required to be flush with the printed-wiring board, those components that do lift off the board to a maximum of 3.17 mm (0.125 in) shall not be cause for rejection or rework as long as the overall height of the component does not exceed the specified product height requirements.

19.3 Vertical Mounting

The following information describes information for mounting components vertically.

1. Vertically mounted components such as resistors or other axial lead devices that must be mounted perpendicular to the printed-circuit board shall be insulated with sleeving as required. This does not include disc capacitors.
2. The bend of the upper lead must conform to the bend radius criteria. See heading 16, *Component Lead Forming (Axial Leads)*.
3. All glass pack vertically mounted components must be raised off the printed-wiring board at least 1.59 mm (0.063 in) and no more than 3.17 mm (0.125 in) to allow for contraction and flexure of the printed-wiring board and the physical stress that may be encountered during assembly. See Figure 42.

Figure 42: Vertical Mounting


Bend radius no less than lead diameter and no more than 3.17 mm (0.125 in)
Off board no less than 1.59 mm (0.062 in) and no more than 3.17 mm (0.125 in)
Sleeving
Bend radius no less than lead diameter and no more than 3.17 mm (0.125 in)
Off board no less than 1.59 mm (0.062 in) and no more than 3.17 mm (0.125 in).

NOTE

Vertically mounted insulated components, such as disc capacitors, may be bent a maximum of 45 degrees perpendicular to the printed-wiring board to meet height requirements. In no case shall uninsulated components touch other uninsulated components.

20 DENTED/DEEPLY SCRATCHED COMPONENTS

Any components which exhibit obvious dents are unacceptable.

20.1 Optimal (Reference)

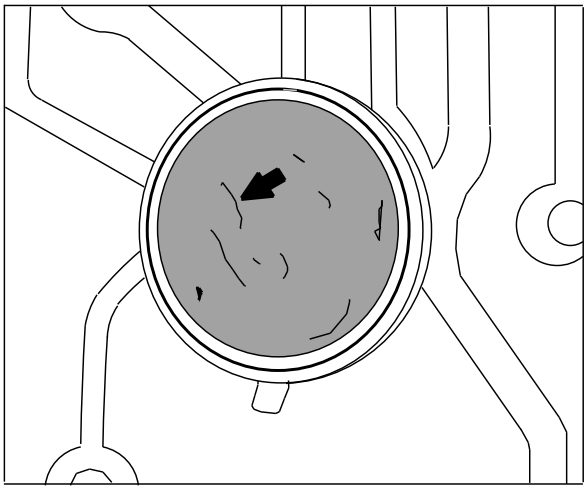
No physical damage to component.

20.2 Acceptable Minimum

The following information describes acceptable minimum conditions.

1. Slightly concave top (dents) on metal can transistors. See Figure 43 and *EL-MF116-01*, Photograph 1-21.
2. Small machine impressions.
3. Minor scratches in the component body.

Figure 43: Acceptable Minimum: Slightly Dented Transistor

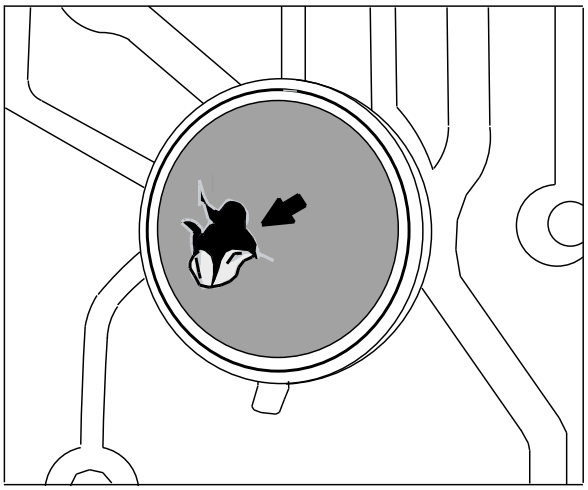


20.3 Unacceptable

Major Defect

Deep, obvious dents, sharp impressions, cuts or deep scratches that protrude into the component body, are not acceptable. See Figure 44 and *EL-MF116-01*, Photograph 1-22.

Figure 44: Unacceptable: Damaged Transistor



21 COMPONENT BODY DAMAGE

Chipped or damaged insulation on a component body, such as resistors, transistors, capacitors, micrologic integrated circuits, is not acceptable if the damage extends into the functional portion of the component.

21.1 Meniscus

Meniscus is a coating that extends onto the lead of a component (mostly capacitors). Meniscus may extend into the board's plated-through hole, forming an air seal or plug, affecting the solder flow. Therefore, it is important to have a good solder fillet on side 2.

21.2 Optimal (Reference)

The following information describes optimal (reference) conditions.

1. Meniscus is not present on the component leads.
2. Meniscus does not extend into the plated-through holes. There is a solder fillet around the component leads on side 1.
3. There are good solder fillets on side 2.

21.3 Acceptable Minimum

The following information describes acceptable minimum conditions.

1. Small chip off the top, sides, or corners of the component body (not into the metallized portion of the body). See Figure 45 and *EL-MF116-01*, Photograph 1-23.
2. Meniscus on leads on side 1. See Figure 46 and *EL-MF116-01*, Photograph 1-24.
3. Good solder fillet on side 2.
4. Meniscus not removed from component leads where the meniscus extends into the module access holes.

Figure 45: Acceptable Minimum: Component Body Damage

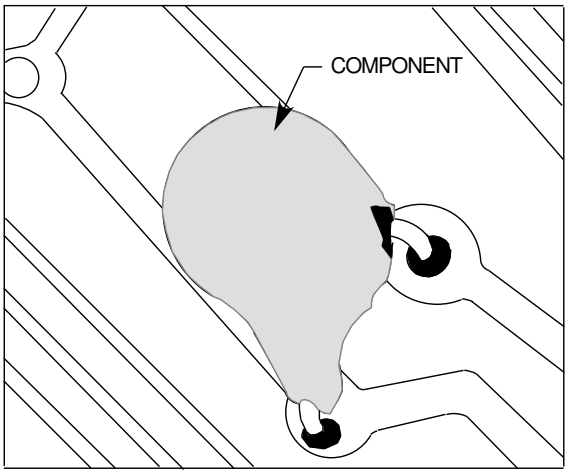
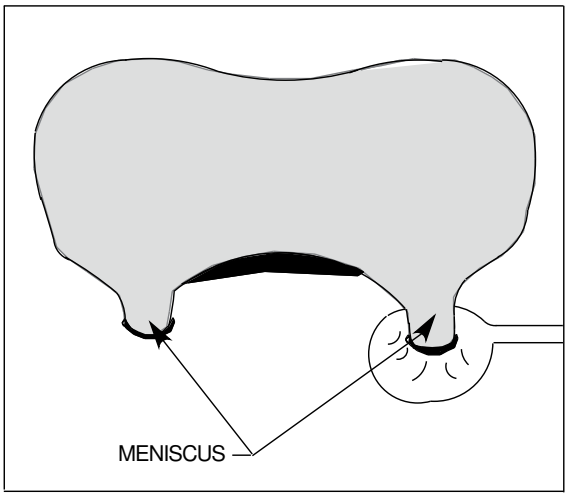


Figure 46: Acceptable Minimum: Component Body Damage - Meniscus on Leads

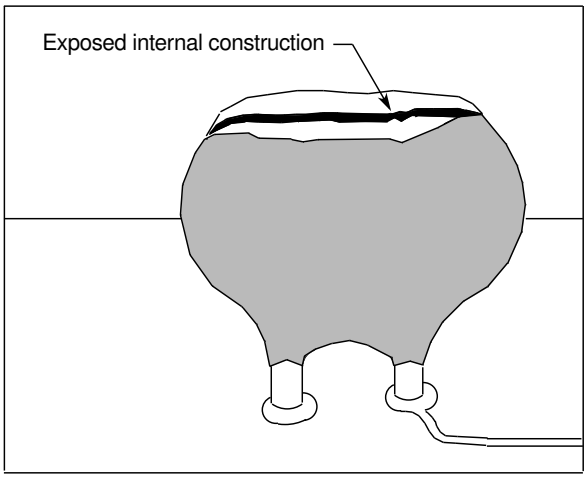


21.4 Unacceptable

Major Defect

1. Chips broken off the component body exposing the internal construction (functional portion of the component). See Figure 47 and *EL-MF116-01*, Photograph 1-25.
2. Meniscus visible in solder joint on side 2.

Figure 47: Unacceptable: Component Body Damage



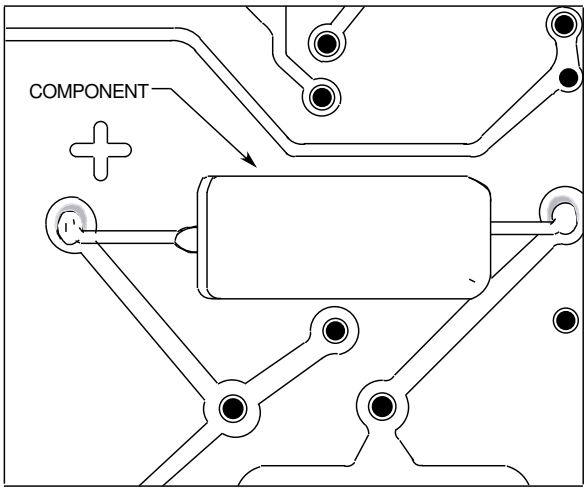
22 POLARIZED CAPACITORS

All polarized capacitors, as well as other polarized components, shall be mounted with the polarity as specified.

22.1 Optimal (Reference)

Correctly installed polarized capacitor. See Figure 48 and *EL-MF116-01*, Photograph 1-26.

Figure 48: Optimal (Reference): Polarized Capacitors



22.2 Acceptable Minimum

There are no acceptable minimum conditions for mounting polarized components.

22.3 Unacceptable

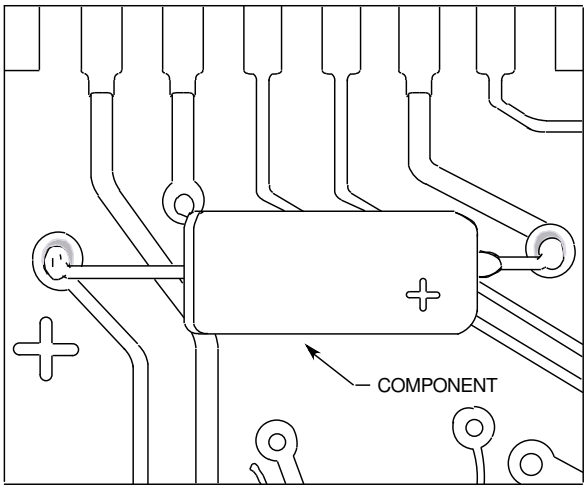
Critical Defect

Polarity on electrolytic capacitors is reversed. (Component polarity is etched on the board.) See Figure 49 and *EL-MF116-01*, Photograph 1-27.

Major Defect

All other polarized components whose polarity has been reversed (for example, diodes).

Figure 49: Unacceptable: Polarized Capacitors



23 COMPONENT MARKINGS

Polarity markings, as well as other component markings (part numbers, and so on) that are not visible on the component body after soldering, shall not be considered cause for rejection. Markings that are not visible on the component body *before* soldering shall be cause for rejection of that component.

23.1 Optimal (Reference)

Component markings have not been removed and components are mounted so that markings, such as part numbers, polarity, and so on, are visible.

23.2 Acceptable Minimum

Component markings are not visible after soldering.

23.3 Unacceptable

Major Defect

Component markings are not visible before being soldered on the board.

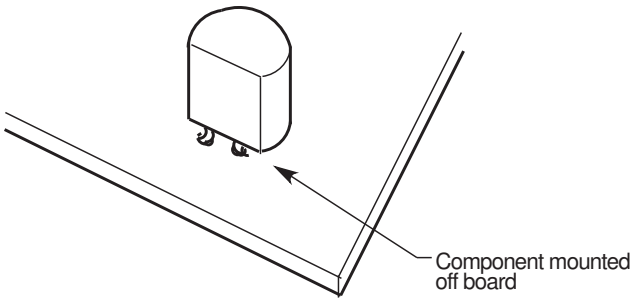
24 RADIAL LEAD COMPONENTS - NO SPACER

When a spacer is not specified, the component shall be mounted with a minimum clearance of 1.59 mm (0.063 in) from the surface of the printed-wiring board.

24.1 Optimal (Reference)

Components mounted off the board. See Figure 50.

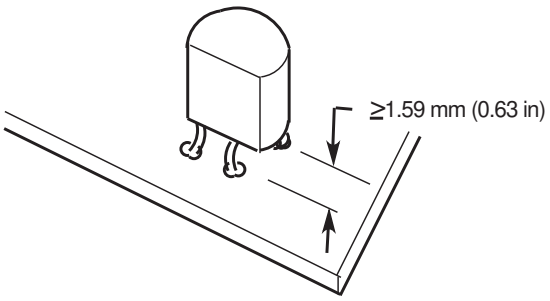
Figure 50: Optimal (Reference): Radial Lead Components - No Spacer



24.2 Acceptable Minimum

Component mounted off printed-wiring board with clearance greater than or equal to 1.59 mm (0.063 in), provided component does not exceed product height restrictions. See Figure 51.

Figure 51: Acceptable Minimum: Radial Lead Components - No Spacer



24.3 Unacceptable

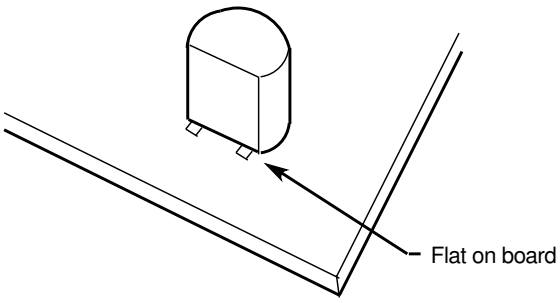
Major Defect

Conductive components mounted flat and in contact with the board.

Minor Defect

Nonconductive components mounted flat and in contact with the board. See Figure 52.

Figure 52: Unacceptable: Radial Lead Components - No Spacer



25 RADIAL LEAD COMPONENTS - WITH SPACER

The following information describes acceptable and unacceptable conditions for mounting radial lead components with spacers.

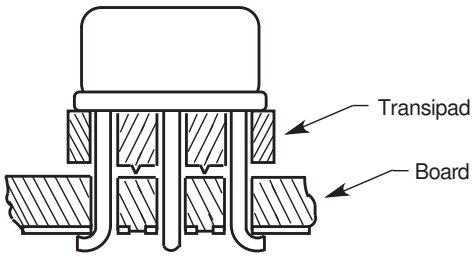
25.1 Transistors (Transipad)

When a spacer (transipad) is used, the pad shall be flush with the board. The bottom of a metal transistor should be flush with the top of the transipad. The bottom of plastic body transistors should be as close as possible to the top of the transipad. Transipads shall be mounted with legs of spacer towards the printed-wiring board.

25.2 Optimal (Reference)

Both transistor and transipad are flat on the board. See Figure 53.

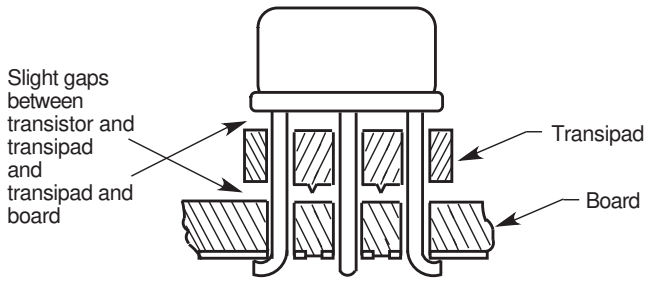
Figure 53: Optimal (Reference): Radial Lead Components - With Spacer



25.3 Acceptable Minimum

1. Gap between transistor transipad or transipad and board is less than one lead diameter. See Figure 54.
2. Inverted transipad.

Figure 54: Acceptable Minimum: Radial Lead Components - With Spacer

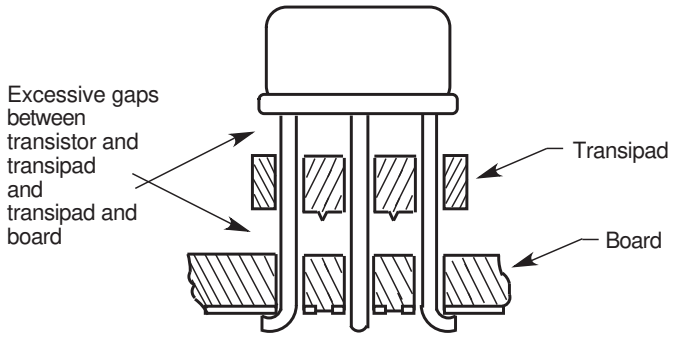


25.4 Unacceptable

Incidental Defect

Gap between transistor and transipad or transipad and board is greater than one lead diameter. See Figure 55.

Figure 55: Unacceptable: Radial Lead Components - With Spacer



26 SUPPORTED DUAL-NONAXIAL

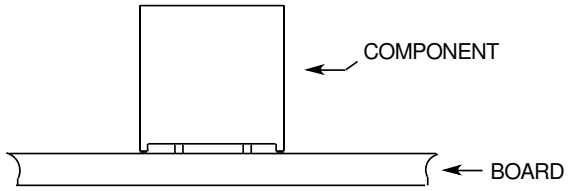
The following mounting information applies to components that are supported with standoffs integral to the component body.

26.1 Optimal (Reference)

The following information describes optimal (reference) conditions for supported dual-nonaxial components. See Figure 56.

1. Component is perpendicular and base is parallel to board surface.
2. Component shall be seated with each standoff in contact with the board surface.

Figure 56: Optimal (Reference): Supported Dual-Nonaxial

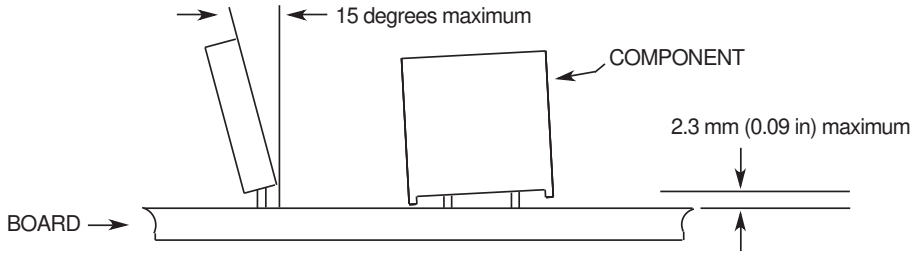


26.2 Acceptable Minimum

The following information describes acceptable minimum conditions. See Figure 57.

1. Component inclination does not exceed 15 degrees from vertical.
2. Base of component is parallel to board surface within 2.3 mm (0.09 in).
3. Space between base of component and board surface shall not exceed 2.3 mm (0.09 in).
4. Slight movement of the component is acceptable provide the above measurements are met.

Figure 57: Acceptable Minimum: Supported Dual-Nonaxial



26.3 Unacceptable

Space between the base and board surface is more than 2.3 mm (0.09 in).

27 RAISED COMPONENTS

The following information describes information about raised components.

1. All components are required to be mounted flush to the printed-wiring board except those required to be raised by the engineering drawings for that module.
2. For components required to be raised, the following criteria shall be used.
   a. The component shall be raised a minimum of 0.79 mm (0.031 in) from the printed-wiring board.
   b. The component shall be raised a maximum of 4.76 mm (0.188 in) from the printed-wiring board, but under no circumstances should the maximum height exceed requirements stated under heading 19, *Component Mounting*.

27.1 Optimal (Reference)

Raised components should be mounted between 0.79 mm (0.031 in) and 4.76 mm (0.188 in).

27.2 Acceptable Minimum

Raised components at a maximum of 4.76 mm (0.188 in) or at a minimum of 0.79 mm (0.031 in) from the board are acceptable.

27.3 Unacceptable

Major Defect

Maximum height limits are exceeded.

Minor Defect

Minimum height requirements are not met.

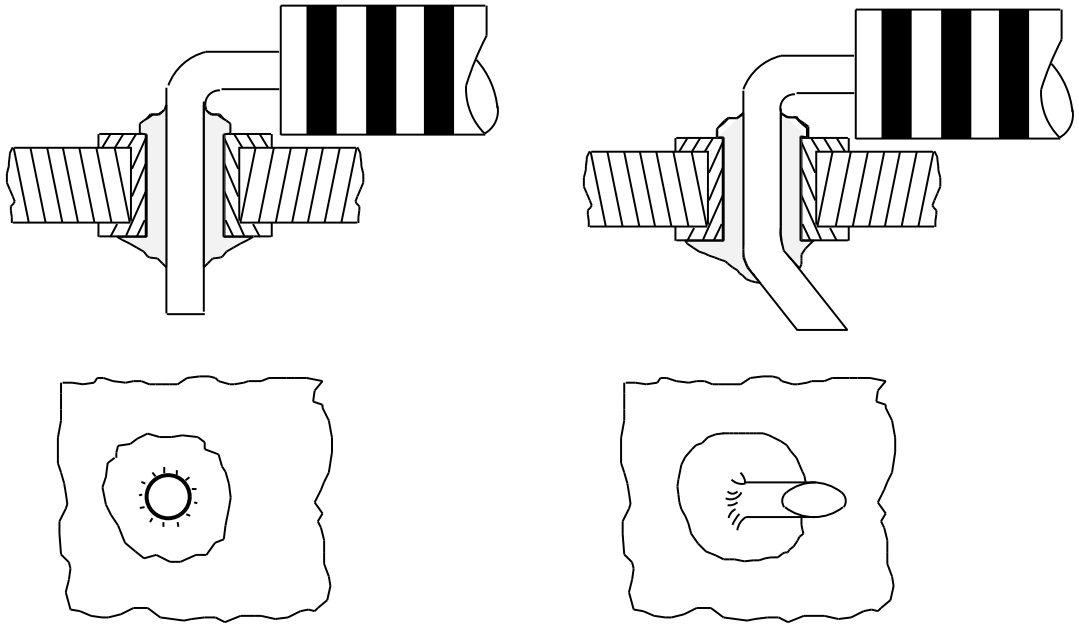
28 MACHINE ROUTED LEADS

Defects such as burrs, caps, or flags are unacceptable on routed leads. All leads having these defects must be removed.

28.1 Optimal (Reference)

Lead has been evenly cut. No distortion of the lead diameter. See Figure 58.

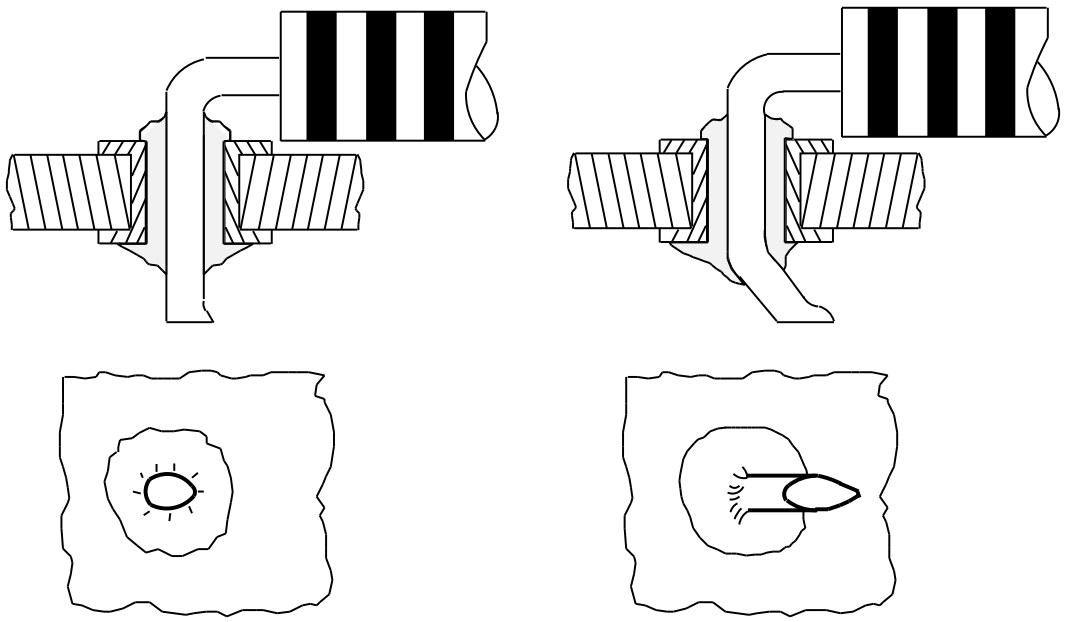
Figure 58: Optimal (Reference): Machine Routed Leads



28.2 Acceptable Minimum

Slight distortion of lead diameter and distorted material that cannot be removed by hand is acceptable. This distortion may indicate that the router is out of adjustment or that the blade is dulling. See Figure 59.

Figure 59: Acceptable Minimum: Machine Routed Leads

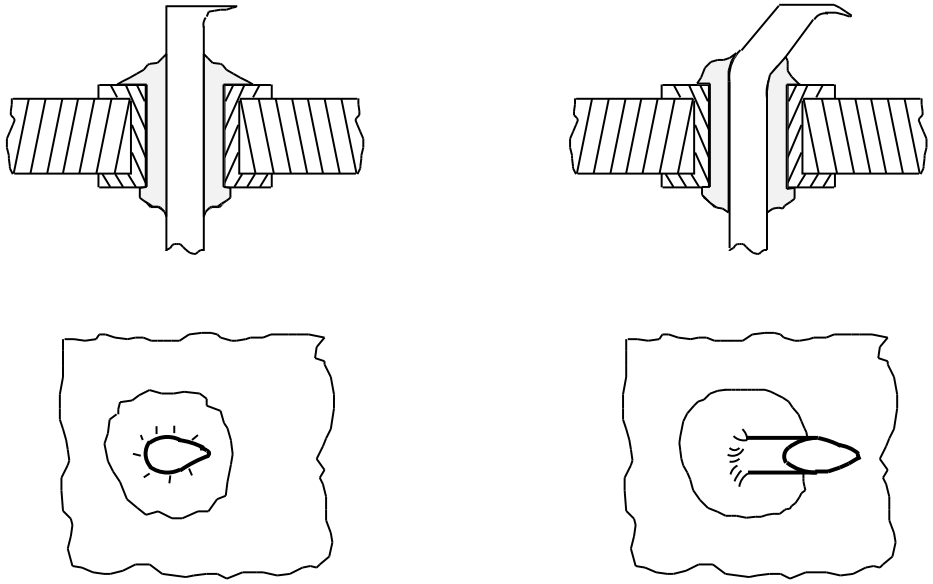


28.3 Unacceptable

Minor Defect

Defects such as burrs, caps, or flags are unacceptable on routed leads. Burrs, caps, or flags could become dislodged from the lead so they should be hand-trimmed. See Figure 60.

Figure 60: Unacceptable: Machine Routed Leads



29 SEPARATION DISTANCE (SHORTING AND FLASHOVER)

Unless otherwise specified, the distance between vertical, multilead components, metallic, nonconnected component leads, conductors, ground planes, hardware, and so on, shall not be less than 0.51 mm (0.020 in). This is a workmanship parameter to prevent the shorting of flexible or movable component leads, hardware, and so on, and does not apply to fixed design distances such as printed-wiring board conductor separation.

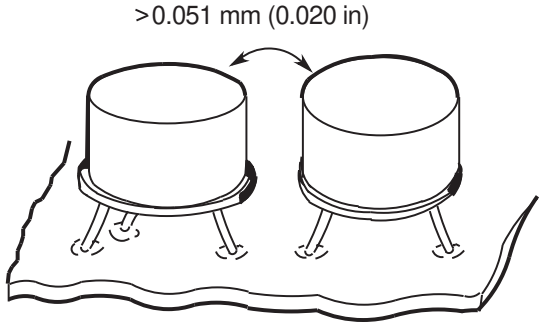
NOTE

The criteria on this page applies to standard logic modules. For high voltage models, refer to *DEC STD 119-1 Digital Product Safety - Design Criteria.*

29.1 Optimal (Reference)

Metal components are straight and maintain a distance greater than 0.51 mm (0.020 in). See Figure 61.

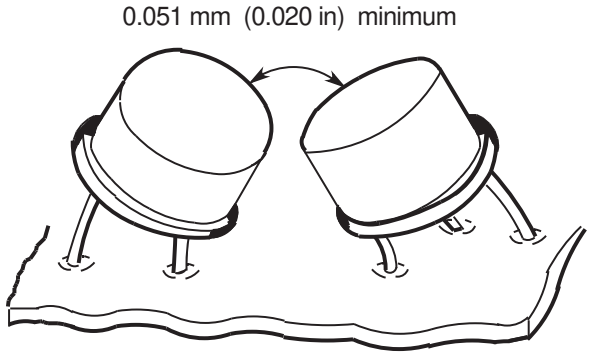
Figure 61: Optimal (Reference): Separation Distance



29.2 Acceptable Minimum

Metal components separated by a minimum of 0.51 mm (0.020 in). See Figure 62.

Figure 62: Acceptable Minimum: Separation Distance

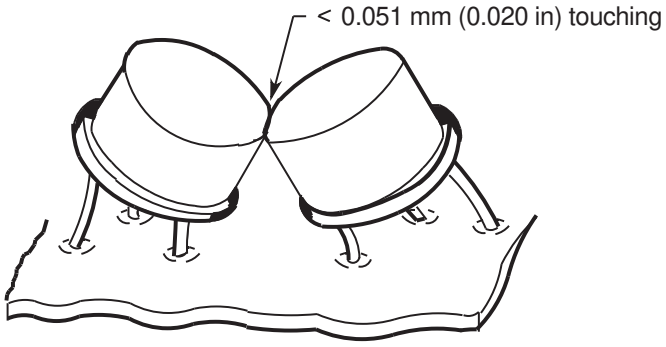


29.3 Unacceptable

Major Defect

Metal components whose distance between each other is less than 0.51 mm (0.020 in) See Figure 63.

Figure 63: Unacceptable: Separation Distance



30 TILTED COMPONENTS

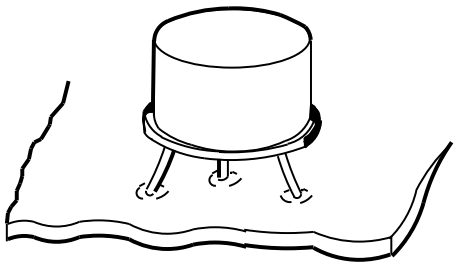
Components that are tilted shall meet the following conditions.

1. Vertical, uninsulated multilead components (metal transistor cans, 3 or more leads) shall not have their vertical axis deviate from the perpendicular of the printed-wiring board surface by more than 20 degrees. An example would be a metal body transistor.
2. If vertical-mounted, multilead, insulated components are tilted, they are acceptable provided the component leads retain a minimum of one lead diameter separation.

30.1 Optimal (Reference)

Components are mounted vertically. See Figure 64.

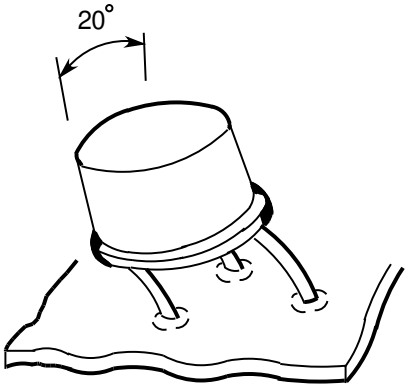
Figure 64: Optimal (Reference): Tilted Components



30.2 Acceptable Minimum

Components mounted 20 degrees off the vertical axis. See Figure 65.

Figure 65: Acceptable Minimum: Tilted Components

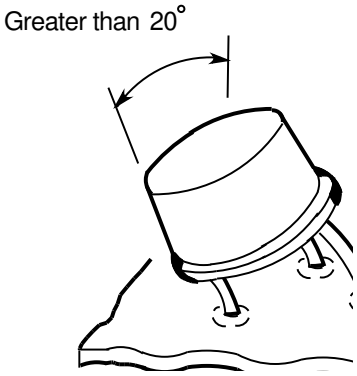


30.3 Unacceptable

Minor Defect

Components mounted with a deviation from the vertical greater than 20 degrees. See Figure 66.

Figure 66: Unacceptable: Tilted Components



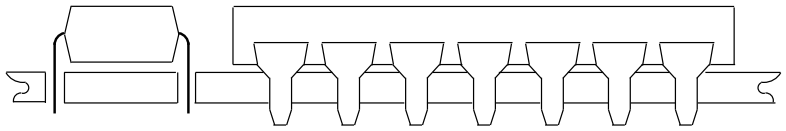
30.4 Multileaded Component Mounting

The following conditions apply to multileaded components.

30.4.1 Optimal (Reference)

Standoff step on all leads rests on land and lead protrusion meets requirements described in subhead 17. See Figure 67.

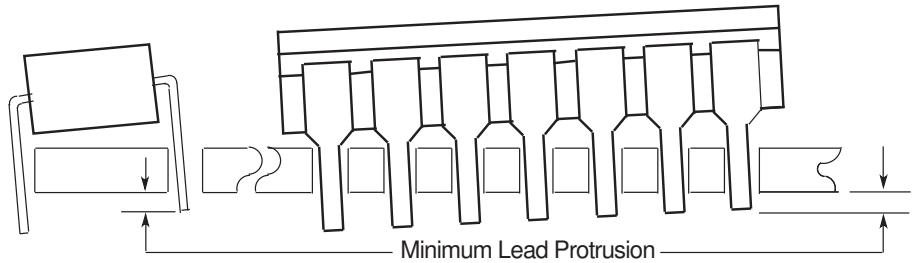
Figure 67: Optimal (Reference): Multileaded Component Mounting



30.4.2 Acceptable Minimum

Amount of tilt is limited by minimum lead protrusion and height requirements. Refer to heading 17, *Component / Wire Lead Protrusion (Side 2, Clinched and Unclinched)* for lead protrusion requirements. See Figure 68.

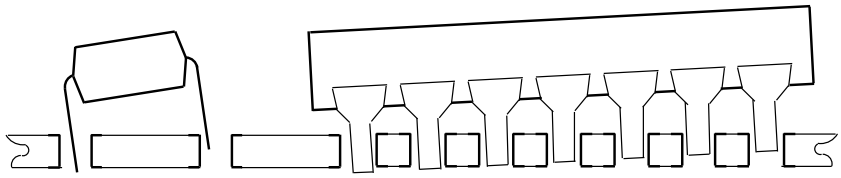
Figure 68: Acceptable Minimum: Multileaded Component Mounting



30.4.3 Unacceptable

Tilt of the component exceeds allowable limits and the lead protrusion does not meet acceptance requirements. Refer to heading 17, *Component / Wire Lead Protrusion (Side 2, Clinched and Unclinched)* for lead protrusion requirements. See Figure 69.

Figure 69: Unacceptable: Multileaded Component Mounting



31 HERMETICAL SEALS

Hermetically-sealed components such as miniature relays, glass-sealed capacitors, diodes, transformers, power transistors, crystals, reed relays, integrated circuits (ICs), and so on, shall not have seals that are chipped, cracked, or grazed.

NOTE

In the manufacturing of certain types of components (such as plastic ICs), pieces of plastic from the mold may be noted between the leads near the body. Removal of these pieces will not affect the hermetic seal of the component.

31.1 Optimal (Reference)

No evidence of seal damage.

31.2 Acceptable Minimum

Slight crack or void next to the lead that does not endanger the seal.

31.3 Unacceptable

Major Defect

Cracked or broken seals/voids.

32 CIRCUITRY BRIDGES (SHORTS)

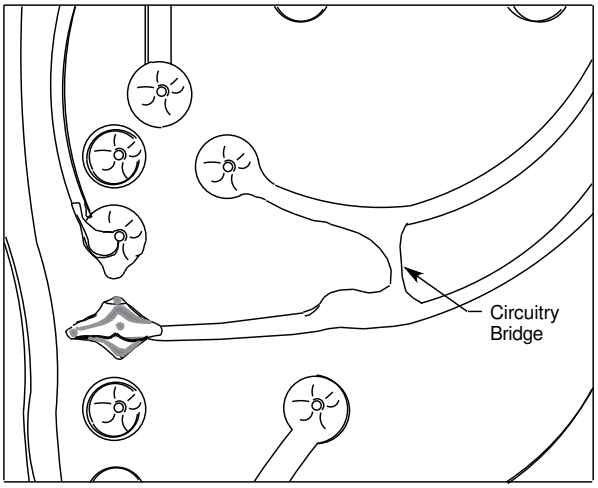
A circuit bridge is a continuous conductive path (short), generally caused by excess solder, between two or more adjacent conductive surfaces. There are no acceptable conditions for circuitry bridging.

32.1 Unacceptable

Major Defects

1. Solder bridging circuitry, pads, or both. See Figure 70 and *EL-MF116-01*, Photograph 1-28.
2. Excessive solder bridging circuits.

Figure 70: Unacceptable: Circuitry Bridge (Shorts)



33 COLD SOLDER JOINT

A cold solder joint has a rough, chalky, or crystallized, dull piled-up appearance. The interface of the solder with the component lead does not have a smooth fillet.

NOTE

This defective condition only occurs as a result of poor manual soldering techniques. Inspection criteria for solder joints produced by mass reflow techniques is described in *DEC STD 116-9 Workmanship Standards Manual - Surface Mount*..

33.1 Optimal (Reference)

The following information describes optimal (reference) conditions.

1. Good solder fillet adhering to both the lead and pad. See *EL-MF116-01*, Photograph 1-29.
2. Solder fillet is complete between pad and lead on side 1 and side 2.
3. Clean, smooth undisturbed solder surface with concave fillet.

33.2 Acceptable Minimum

There are no acceptable minimum conditions for cold solder joints side 1 or side 2.

33.3 Unacceptable

Major Defect

The solder has not bonded the lead to the pad. The appearance is usually dull and chalky. See *EL-MF116-01*, Photograph 1-30.

34 DEWETTING/WETTING

The following is information regarding dewetting and wetting solder conditions.

34.1 Dewetting

1. Dewetting is characterized by solder not completely covering the surfaces to be bonded. Solder appears as droplets or balls having withdrawn from previously wet adjacent areas or never wetting them at all. The maximum dewetting acceptable is 15 percent of the pad area. No dewetting is to occur between pad and lead.
2. Dewetting is produced when molten solder contacts the conductor surface and recedes, leaving only a thin film of solder and forming an alloy bond. Dewetting usually occurs when insufficient heat or flux is applied or when a contaminated surface is present.

34.2 Wetting

The wetting action of solder occurs when the oxide coating has been removed and the molten solder has spread out into thin film that covers the solderable surface.

34.3 Optimal (Reference)

Good wetting on lead and pad (side 1 and side 2). See *EL-MF116-01*, Photograph 1-31.

34.4 Acceptable Minimum

Not more than 15 percent of the pad has dewetted on side 1 and side 2. See *EL-MF116-01*, Photograph 1-32.

34.5 Unacceptable

Minor Defect

Fifteen percent or more of the pad has dewetted.

Major Defect

Dewetting between pad and lead.

35 EXCESSIVE SOLDER

The following is information regarding excessive solder conditions.

1. The solder may be considered excessive when the contour of the wire (on side 2) is not visible.
2. Solder is excessive when possibility exists of shorting to adjacent circuit runs or to the body of a metal component.

35.1 Optimal (Reference)

Good solder fillet adhering to both lead and pad with complete coverage. See *EL-MF116-01*, Photograph 1-33.

35.2 Acceptable Minimum

Evidence of lead and pad wetting is visible. See *EL-MF116-01*, Photograph 1-34.

35.3 Unacceptable

Minor Defect

Solder is excessive where evidence of wetting of lead and pad is not visible (side 2). See *EL-MF116-01*, Photograph 1-35.

Major Defect

Convex fillet with the possibility of shorting to adjacent circuit runs (side 1 or 2) or to the leads of any components.

36 INTERFACIAL HOLES (PTH MODULES) WITH COMPONENTS (WITH OR WITHOUT GRIPLETS)

All component leads inserted into an interfacial hole (plated-through hole (PTH), eyelet, and so on) with attached conductor shall exhibit the following solder conditions:

1. The PTH solder fill shall be sufficient to allow visual inspection of the solder transition between the lead and PTH barrel from side 1 and 2.
2. Shallow solder joints shall exhibit good lead to barrel wetting on side 2 and on the visible portion of side 1. There will be no evidence of nonwet, dewet, voids, or other solder connection imperfections.
3. Full solder joints shall exhibit good lead-to-pad wetting on side 2 and on the visible portion of side 1. A smooth, shiny solder surface transition must be visible around a minimum of 50 percent of the lead circumference (or 75 percent of the circumference when a void is present). Refer to heading 40, *Pads - Clinched/Unclinched Leads (PTH Modules)*, for more information.
4. Exceptions:

   Visible indication of lead-to-barrel wetting on side 1 is not required:

   a. For IC leads that are connected to power and ground planes (inner layers) of multilayer boards, if all other leads on the IC meet requirements 1, 2, and 3 above.
   b. For components, such as connectors, IC sockets, capacitors with meniscus, which are mounted so that the PTH is not visible from side 1, as long as other components on the board meet requirements 1, 2, and 3 above.
   c. For a component lead connected to a power or ground plane, as long as other components on the board meet requirements 1, 2, and 3 above. This verifies that the board is solderable. Other leads not connected to an inner layer must meet the requirements of 1, 2, and 3 above.
5. Solder terminations of rigid leaded components such as PGAs, connectors and sockets, may not exhibit a lead outline on side 2 due to product design. If the visible portion of the side 1 fillet is acceptable, this condition should not be rejected.

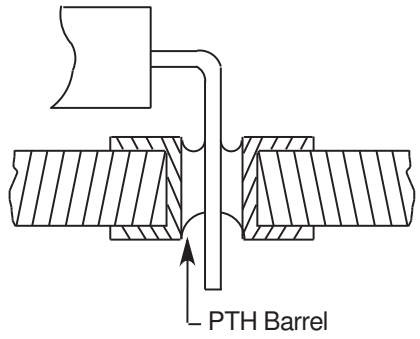
36.1 Optimal (Reference)

Good solder fillet. Full solder joint with complete wetting of component lead and pad, both sides.

36.2 Acceptable Minimum

The visible portion of the joint shows a smooth solder transition between lead and PTH barrel on both side 1 and side 2. See Figure 71 and *EL-MF116-01*, Photographs 1-36 and 1-37.

Figure 71: Acceptable Minimum: Interfacial Holes

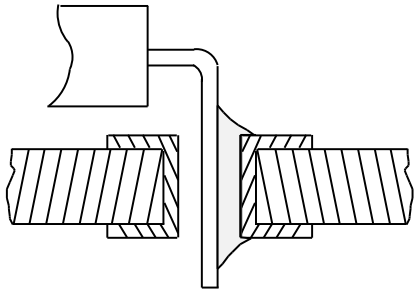


36.3 Unacceptable

Major Defect

Void in solder completely through the board. No solder flow or wetting of lead or pad. The solder joint is fractured. See Figure 72 and *EL-MF116-01*, Photograph 1-38.

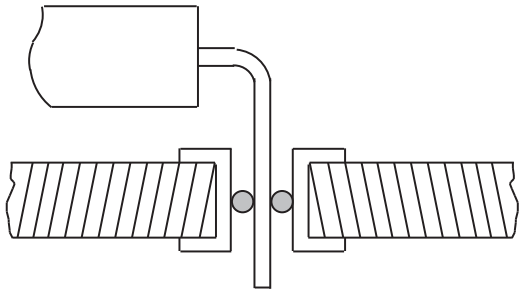
Figure 72: Unacceptable: Interfacial Holes - Void



Major Defect

Lack of smooth transition exists from either lead to solder or from solder to PTH. See Figure 73.

Figure 73: Unacceptable: Interfacial Holes



Major Defect

Solder fill is not sufficient to permit visual confirmation of wetting. Refer to heading 36, *Interfacial Holes (PTH Modules) with Components (With or Without)* for exceptions.

37 INTERFACIAL HOLES (PTH MODULES) WITHOUT COMPONENT LEADS

All unused holes on printed-wiring boards with interfacial connections (PTH modules) that do not have component leads or hookup wires (insulated and uninsulated types) inserted into them shall conform to the following:

1. Can have no cracks in the periphery of the plated-through hole.
2. Can have no voids in the plated-through hole wall.
3. Does not have to have a solder fillet.
4. Can exhibit poor wetting (nonwet and dewet).
5. Can have large blow holes and pin holes.
6. Can have excess solder provided it does not to exceed requirements described in heading 35, *Excessive Solder*.

38 PRINT AND ETCH MODULES - SOLDER REQUIREMENTS

Print and etch modules do not have plated-through holes. The solder connections are made by bridging the lead to the pad.

Lead Clinch Criteria

A tightly clinched lead is a lead that is bent parallel to the board and is firmly pressed against the pad. A loosely-clinched lead is a lead that is not pressed against the pad or etch.

Solder Criteria

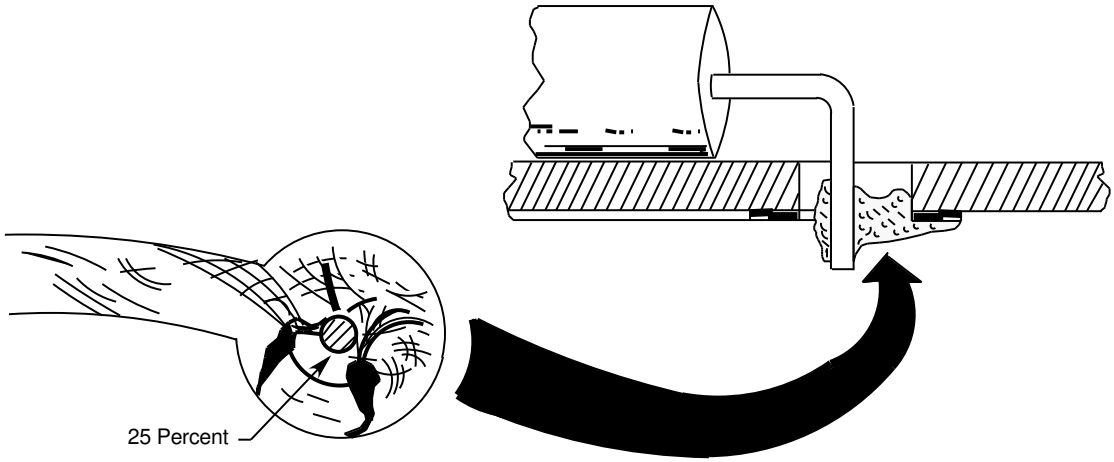
All solder acceptability criteria for modules with plated-through holes applies to print and etch boards. However, the following subheads describes additional acceptance criteria for print and etch modules.

38.1 Acceptable Minimum

Unclinched/Loosely-Clinched Leads

Completed wetting of the lead to the pad. Lead completely embedded in the solder. At least 75 percent of the hole is covered with solder. See Figure 74.

Figure 74: Acceptable Minimum: Unclinched/Loosely-Clinched Leads

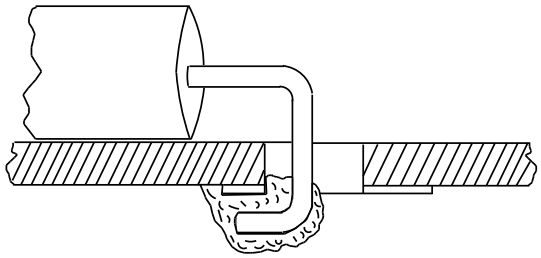


38.2 Acceptable Minimum

Clinched Leads

Good solder fillet adhering to both lead and pad covering lead but not covering the hole with solder. See Figure 75.

Figure 75: Acceptable Minimum: Clinched Leads



38.3 Unacceptable

Major Defects

1. Lead not completely wetted (for clinched and unclinched leads).
2. Lead not completely embedded in the solder (for unclinched or loosely-clinched leads).

39 FRACTURED/DISTURBED SOLDER JOINT

Disturbed joints are characterized by strain marks on the surface or by a rough, gritty appearance. Fractured joints are characterized by the separation of the component lead from the solder fillet. There are no acceptable conditions for disturbed or fractured solder joints.

39.1 Unacceptable (Disturbed Joints)

Major Defect

Strain marks and dull color (rough and gritty appearance) are typical of disturbed joints. See *EL-MF116-01*, Photograph 1-39.

39.2 Unacceptable (Fractured Joints)

Major Defects

1. Solder fillet has separated from the component lead. See *EL-MF116-01*, Photograph 1-40.
2. Solder fillet has separated from circuit pad.

40 PADS - CLINCHED/UNCLINCHED LEADS (PTH MODULES)

All component leads inserted into printed-wiring boards and not clinched shall exhibit the following:

1. Pads only (no etch conductor attached) can display voids and shall display evidence of wetting of lead to pad.
2. Pads (with etch conductor attached) shall display good solder flow and wetting of component lead to pad (both side 1 and 2) with a maximum of two voids less than the lead diameter per solder connection, either side 1 or side 2, but not both on the same connection.

40.1 Voids

1. A void is acceptable if its size is less than the lead diameter and the lead is wetted around a minimum of 75 percent of its circumference with no indication of a rosin joint.
2. Any number of voids are acceptable on one board provided they meet the criteria described in subhead 40.

40.2 Optimal (Reference)

Minimum solder, complete fillet, good wetting, and no evidence of voids.

40.3 Acceptable Minimum

1. Voids not exceeding the diameter of component lead. See *EL-MF116-01*, Photograph 1-41.
2. Two pin holes per solder connection, either side 1 or side 2, but not both.

40.4 Unacceptable

Major Defects

Voids are larger than the lead diameter. See *EL-MF116-01*, Photograph 1-42.

41 SOLDER BALLS, SOLDER WEBBING, AND ROSIN BONDS

The following information describes acceptable and unacceptable conditions for solder balls, solder webbing/splashes, and rosin bonds on printed-wiring boards.

41.1 Acceptable - Solder Balls

The following acceptable conditions for solder balls should not impact or degrade the functional quality or reliability of the product.

1. Solder balls are randomly dispersed across surface of the module.
2. Solder balls are secure to the surface of the module.
3. The diameter of the the solder balls does not exceed the following measurements.

   0.20 mm (0.008 in) on wave soldered PTH products.
   0.13 mm (0.005 in) for mixed and surface mount technology with solder mask.
   Half the design space on boards without solder mask, not to exceed 0.13 mm (0.005 in).
4. Solder balls, regardless of size, are acceptable if they are secured beneath components.

41.2 Unacceptable - Solder Balls

The following information describes unacceptable conditions when solder balls are present. See *EL-MF116-01*, Photograph 1-43, for an example of an unacceptable solder ball.

1. Solder balls are massed together anywhere on the surface of the board. Solder balls that touch each other are not acceptable.
2. Loose solder balls are cause for rejection.

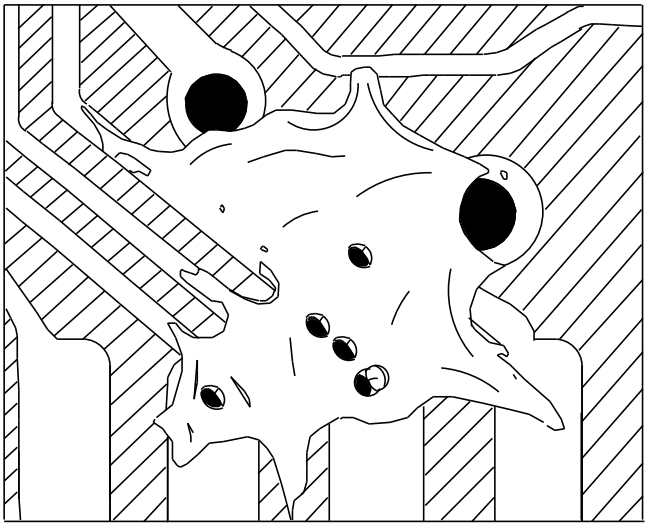
41.3 Rosin Bonds

Rosin bonds are achieved through a layer of solidified flux. In its worst form, this joint has no metallic or electrical continuity and has little physical strength. Rosin bonds are not acceptable.

41.4 Solder Webbing/Splash

Any webbing segment that exceeds the maximum size of 0.13 mm (0.005 in) in the longest axis is not acceptable. See Figure 76 and *EL-MF116-01*, Photograph 1-44.

Figure 76: Unacceptable: Solder Webbing



42 SOLDER PROJECTIONS

Solder projections that exceed 1.59 mm (0.063 in) in height on side 1 or side 2 or within 0.40 mm (0.015 in) of an adjacent conductor, whichever is less, are unacceptable.

Solder projections that reduce the conductor spacing are not acceptable on high power (greater than 42.4 volts peak) boards. Refer to *DEC STD 176-0 Printed-Wiring Board Acceptance Criteria* and *EL-MF786-00, Electronics Technology File,* for printed-wiring board identification information.

42.1 Peaks/Icicles

This condition is basically an excessive solder formation that (because of its freezing shape) is conical, ending with a sharp point.

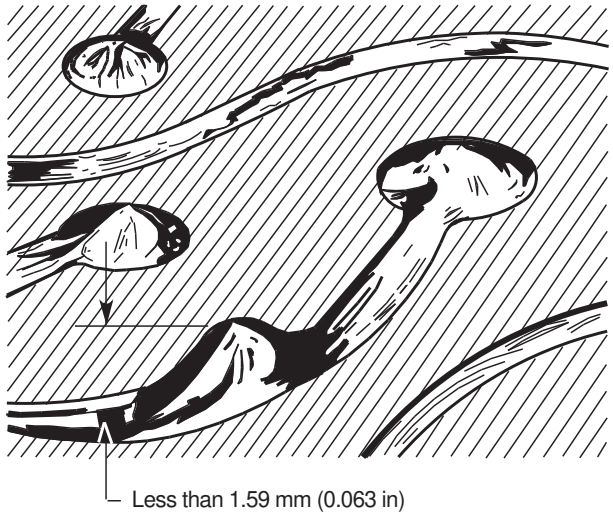
42.2 Optimal (Reference)

No solder projections.

42.3 Acceptable Minimum

Solder projections height shall not exceed 1.59 mm (0.063 in). See Figure 77.

Figure 77: Acceptable Minimum: Solder Projections

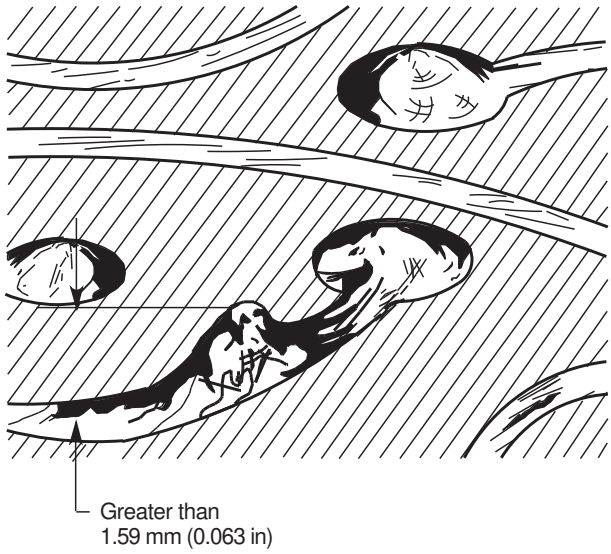


42.4 Unacceptable

Major Defect

Solder projection height exceeds 1.59 mm (0.063 in). See Figure 78.

Figure 78: Unacceptable: Solder Projections



43 TACK SOLDERING (ROUND TO FLAT SURFACE)

Wires (solid or stranded) that are required to be tack soldered to an etch or circuit run shall meet the following conditions.

1. Circuitry width shall be at least 15 percent greater in width than the diameter of the uninsulated wire.
2. The uninsulated portion of a wire end shall not extend past the circuit etch, pad, or finger contact is being soldered to.
3. The uninsulated portion of the wire to be soldered must be parallel and flush to the flat circuit.
4. The contour of the soldered wire must be visible with good wetting on the entire length of the uninsulated portion of the wire. Lead to etch must have a concave solder fillet.
5. The uninsulated portion of the wire which is tack soldered must be a minimum of 3.18 mm (0.125 in) and must not exceed 6.35 mm (0.250 in) .

Caution

Tack soldering is not allowed on fineline modules under any circumstance.

43.1 Optimal (Reference)

Leads are straight and parallel with good wetting and a concave fillet.

43.2 Acceptable Minimum

The following information describes acceptable minimum conditions.

1. Lead is not centered or parallel with circuit and does not extend past the width of the circuit run. See *EL-MF116-01*, Photograph 1-45.
2. Good wetting action.

43.3 Unacceptable

Major Defects

The following information describes unacceptable conditions for tack soldering. See *EL-MF116-01*, Photograph 1-46.

1. Wetting action is poor.
2. Circuit is too small for wire diameter.
3. Wire hangs over circuit run.
4. Circuit spacing is reduced because of nonparallel lead.

44 CONTACT FINGERS (SOLDER)

Solder or solder film on printed-circuit contact fingers shall be considered acceptable, provided it does not intrude into the "minimum gold plating" area of the contact finger as described in *DEC STD 176-0 Printed-Wiring Board Acceptance Criteria*.

44.1 Optimal (Reference)

No solder in the gold plated contact area of the finger.

44.2 Acceptable Minimum

Solder is on the plated area of the finger, but it does not extend into the "minimum gold plating" area.

44.3 Unacceptable

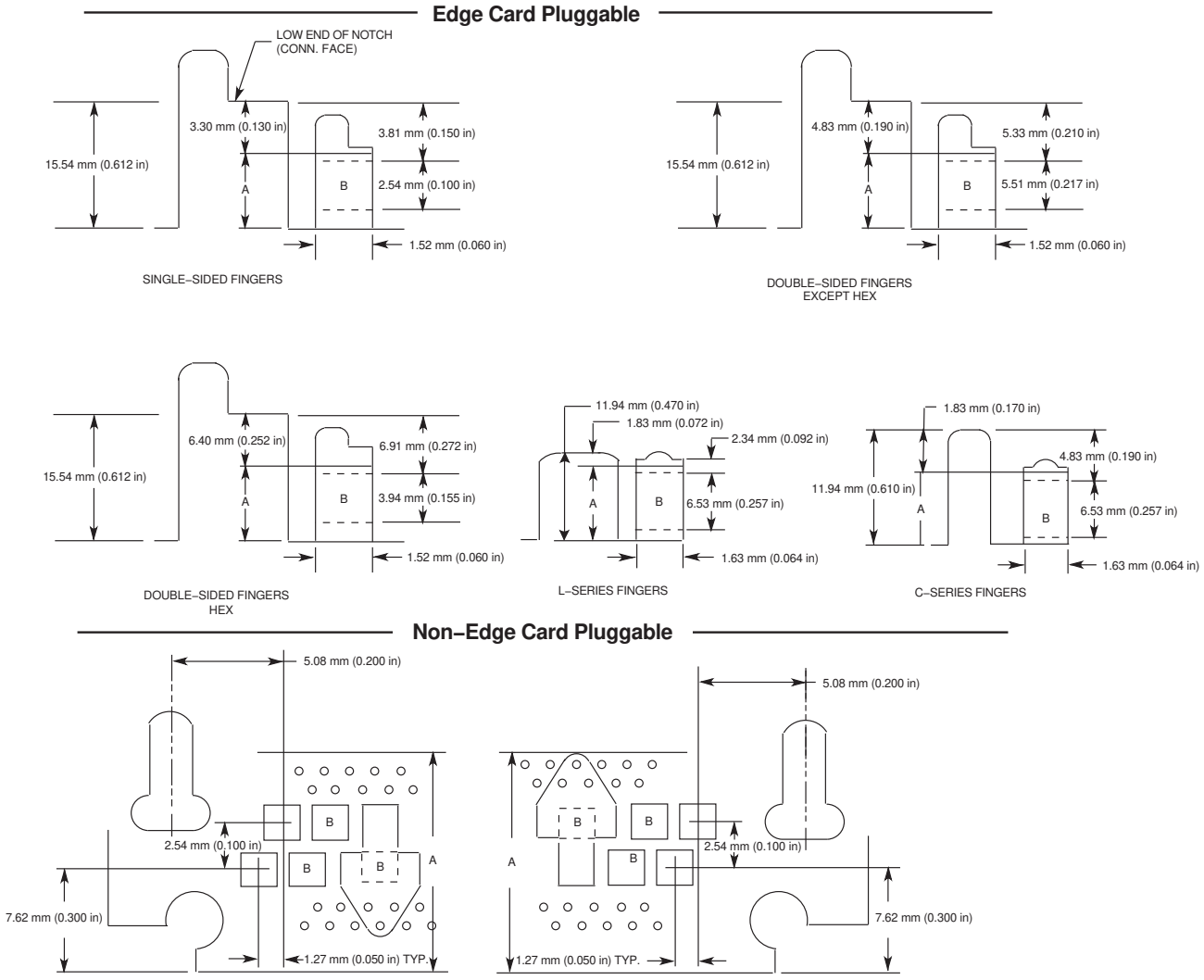
Major Defect

Solder extends into the "minimum gold plating" area of the finger. See Figure 79.

NOTE

The full feature size of T-Series and F-Series gold plated connector tabs is considered the "minimum plated area". Therefore, no solder is allowed. For more details see *D-MD-ELEN624-0-DBU, E-MD-ELEN625-0-DBU,* and *D-MD-ELEN626-0-DBU.* These drawings are contained in *PC Board Engineering Handbook - Standard Circuit and Finger Details*

Figure 79: Minimum Gold Plating Length (Dimension A) and Critical Contact Area (Dimension B)



DIMENSIONS:
A. MINIMUM GOLD–PLATING = 16.51 mm (0.650 in)
B. CRITICAL CONTACT AREA = 2.03 mm (0.080 in) X 2.03 mm (0.080 in) SQUARE PAD

F AND T (VAXBI) SERIES CONNECTORS AND PADS
FOR DETAILS, REFERENCE D–MD–ELEN626–0–DBU,
E–MD–ELEN625–0–DBU, AND D–MD–ELEN624–0–DBU.

45 Solder/Lead Peel Back

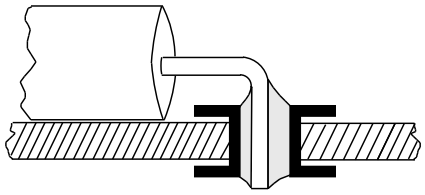
Solder/lead peel back occurs when a lead is manually cut and separates from the solder fillet by no greater than 180 degrees around the lead on side 2 of the module.

This condition can only occur on a manually cut lead. It is not acceptable on single-sided modules. It is not acceptable when minimum solderability criteria exist such as blow holes, grainy solder, cold solder joints, poor wetting, and no-wetting angles.

45.1 Optimal (Reference)

Manually cut lead without bending and causing solder/lead peel back. See Figure 80.

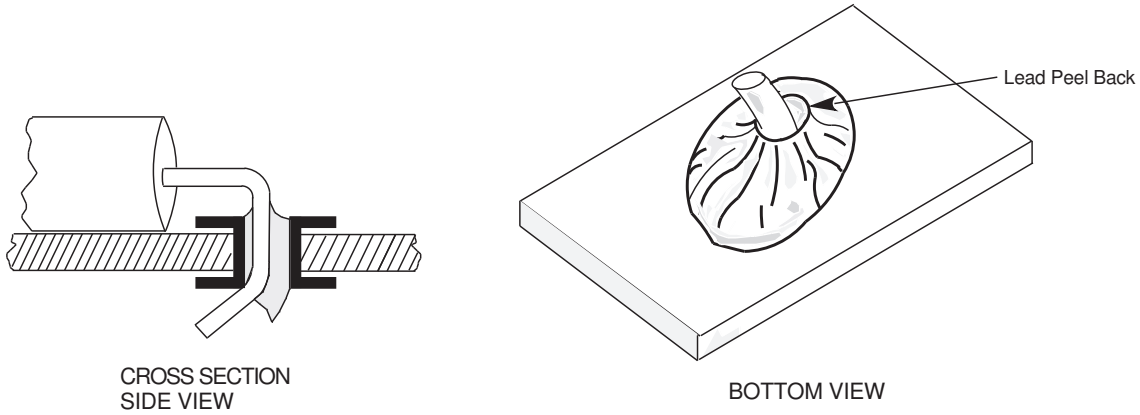
Figure 80: Optimal (Reference): Solder/Lead Peel Back



45.2 Acceptable Minimum

Manually cut lead separating from solder fillet. Solder is not separated more than 180 degrees around the lead. See Figure 81.

Figure 81: Acceptable Minimum: Solder/Lead Peel Back

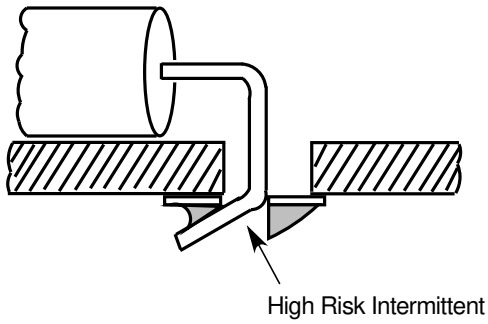


45.3 Unacceptable

Major Defect

Manually cut lead that bends away from solder fillet. See Figure 82.

Figure 82: Unacceptable: Solder/Lead Peel Back (Single-Sided Module)

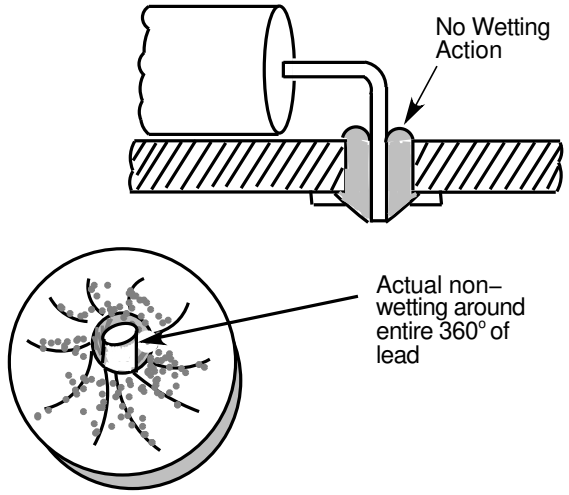


45.4 Unacceptable

Major Defect

1. Manually cutting lead through the solder fillet and pulling lead causing intermittent-type joint. See Figure 83.
2. Contaminated lead, nonwetting, no intermetallic connection.

Figure 83: Unacceptable: Solder/Lead Peel Back



46 Exposed Copper

The following information applies to areas outside of the contact finger area. Refer to heading 8, *Contact Finger and Etch (Damage)* for information on exposed copper on contact fingers.

Exposed copper on fully-assembled printed-wiring boards composed of Soldermask Over Bare Copper (SMOBC), all copper, or plated and fused are acceptable provided they meet the following conditions.

1. Exposed copper on an etch line is less than 3.18 mm (0.125 in) in length.
2. Exposed copper on a large planar area is less than 80.6 mm^2 (0.125 in^2).
3. Exposed copper is on the top surface of a pad outside an acceptable wetted lead-to-pad joint.
4. Exposed copper on the vertical edges of etch lines is acceptable without restrictions.

APPENDIX A REFERENCED DOCUMENTS

A.1 Digital Documents, EL-Class

Document Number	Document Title
EL-00116-09	*DEC STD 116-9 Workmanship Standards Manual - Surface Mount*
EL-00119-01	*DEC STD 119-1 Digital Product Safety—Design Criteria*
EL-00176-00	*DEC STD 176-0 Printed-Wiring Board Acceptance Criteria*
EL-ENPCB-01	*PC Board Engineering Handbook - Standard Circuit and Finger Details*
EL-MF116-01	*Module Assembly Workmanship Photographs*
EL-MF299-00	*Printed-Circuit Boards/Modules: Cleaning Process Contamination*
EL-MF786-00	*Electronics Technology File*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

A.2 Documents External to Digital

Document Number	Document Title
ANSI/IPC-TM-650	*Test Methods Manual*

For a copy of the above document:

In the USA:

American National Standards Institute (ANSI)
1430 Broadway, New York, NY 10018
Telephone (212) 354-3300 x479

In other countries:

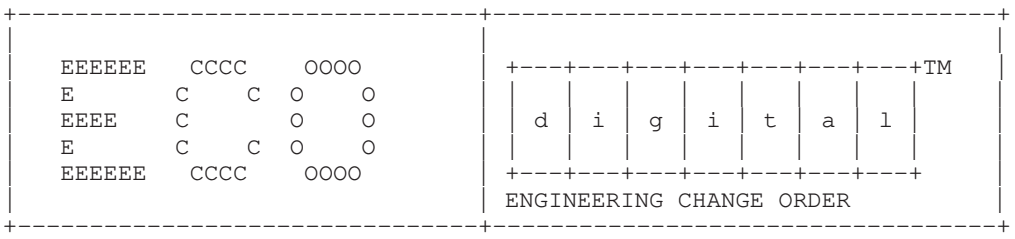
The National Standards Organization

APPENDIX B RELATED DOCUMENTS

B.1 Digital Documents, EL-Class

Document Number	Document Title
EL-00067-00	*DEC STD 067-0 Electrostatic Discharge - Sensitive Devices*
EL-00265-00	*DEC STD 265-0 Module Rework and Repair Standard Procedures*
EL-MF409-00	*Awareness and Prevention of Electrostatic Discharge*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.



ECO No: EL00116-01-NRO{##}
Originator: {}
Location/MS: {}
Cost Center: {}

Page: 1 of 2
Phone: {}
Date Received: 17-Jan-1989
Final Issue: 01-Mar-1993

Unit(s) to be changed: EL-00116-01
Prod. Families Affected: N/A
ECO Type Code: 5 Category: STD
F/S Affected: No FCO Req.: No LOU Code: N/A
Where Used: {}
Documentation Affected: A-DS-EL00116-01-0000, DEC STD 116-1 Workmanship Standards Manual - Module Assembly

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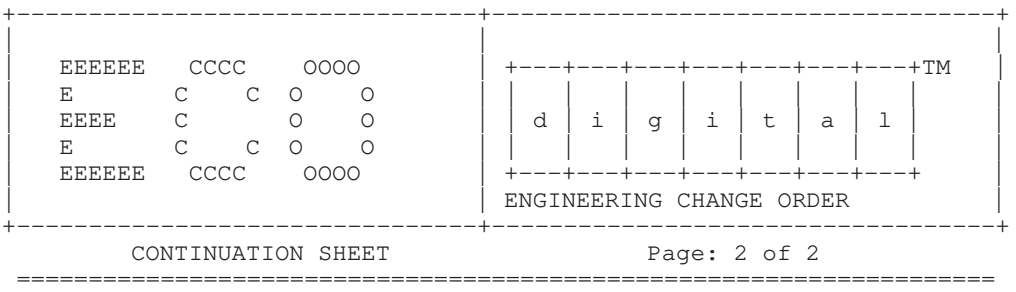
PROBLEM: {}

CORRECTION: {}

BREAK-IN/EFFECT. Immediately.

APPROVAL NAMES		CC	DTN	DATE
Engineering:	{SIGNEE}	{CC}	{DTN}	01-Mar-1993
Stds Process Mgr:	Eric Williams	3VQ	223-4166	01-Mar-1993
SMC Coordinator:	Georgia Ireland	3VQ	234-4368	01-Mar-1993

Charge Number: 95605061 W.O. No: 192587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ECO No: EL00116-01-NRO{##}

ITEM	PART NO.	DOCUMENT NO.	OLD REV	NEW REV
1	EL-00116-01	A-DS-EL00116-01-0000	N	P

DESCRIPTION: Updated acceptable and unacceptable workmanship criteria for module assemblies. Reformated DEC STD 116-1 to allow on-line distribution and to minimize publishing expenses.

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